NOVEMBER 12, 1959

MACHINE DESIGN

A PENTON PUBLICATION — BIWEEKLY

Plastic Extrusions

Contents, Page 3

Size for Size...
New ASCO Midget 3 Way Solenoid Valve provides

UNMATCHED FAST RETURN
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Of Cylinders and Diaphragms

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Circle 401 on Page 19

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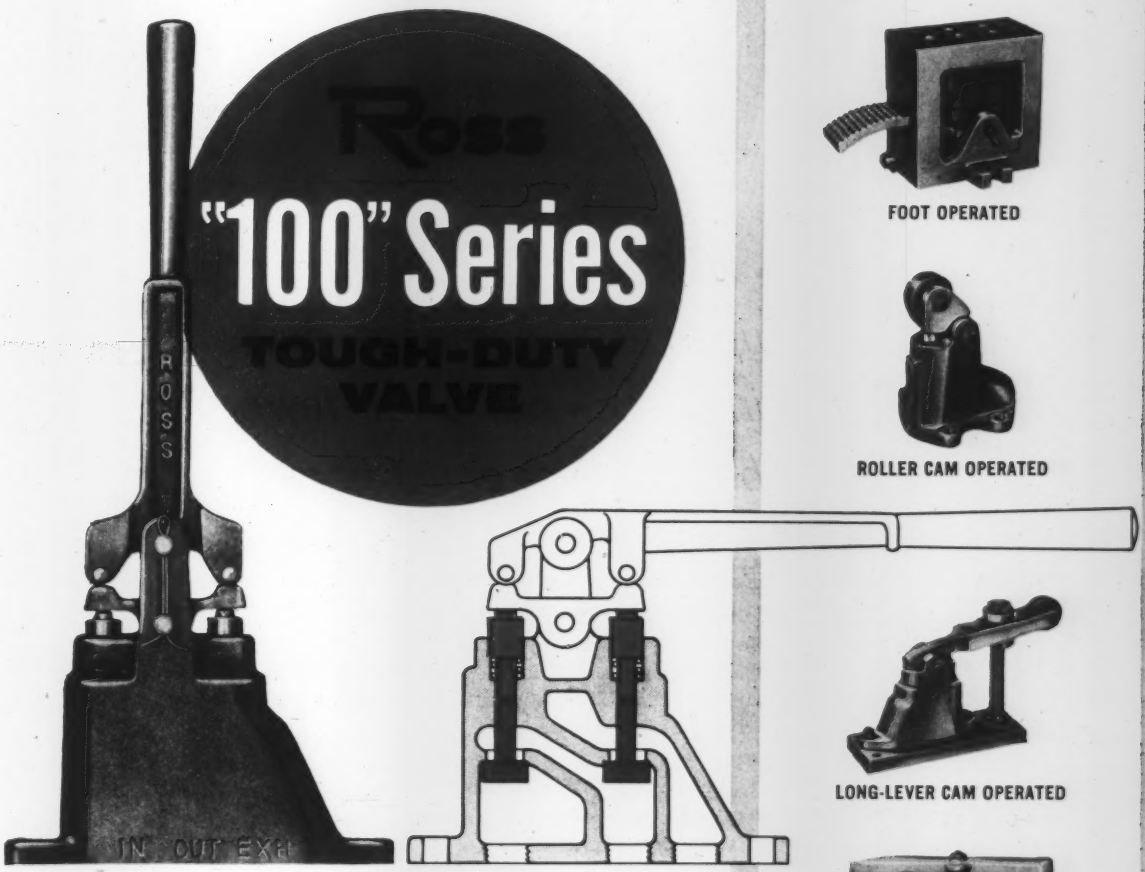
TOUGH-DUTY VALVE



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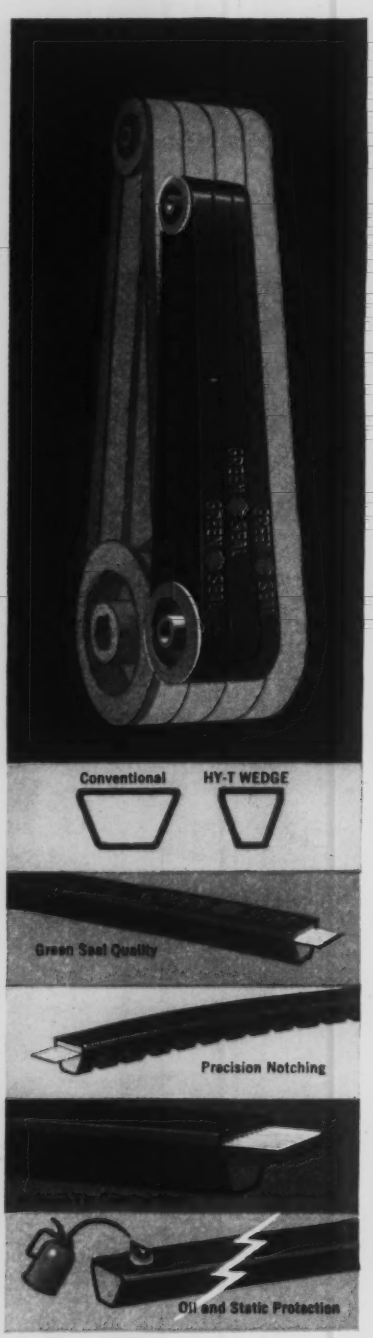
IT'S NEW! IT'S ANOTHER GREAT GREEN ✿ SEAL V-BELT—

HY-T WEDGE



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It's just what you'd expect from the Goodyear specialists who pioneered and patented the first wedge-type V-Belt in '48!

Now Goodyear brings you the HY-T WEDGE, a great new V-Belt design that's stripped clean of free-loading "fat." It's a belt that's *all muscle*—capable of handling substantially greater horsepower—on more compact drives—at lower costs.

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For full details, check with the G.T.M.—Goodyear Technical Man—through your Goodyear Distributor. Or write Goodyear, Industrial Products Division, Lincoln 2, Nebraska, or Akron 16, Ohio.

HY-T WEDGE with the GREEN ✿ SEAL BY

GOODYEAR

THE GREATEST NAME IN RUBBER

HY-T WEDGE, Green Seal—T. M.'s The Goodyear Tire & Rubber Company, Akron, Ohio

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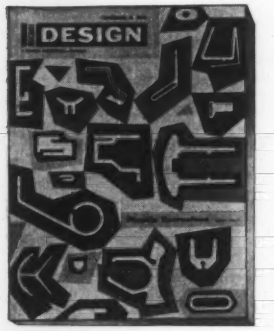

Front Cover: Not the products of a wild cookie-press, but some actual cross sections for extruded plastics appear on George Farnsworth's cover. Examples in R. Marx's article, Page 158, show how to design plastic parts suitable for extruding.

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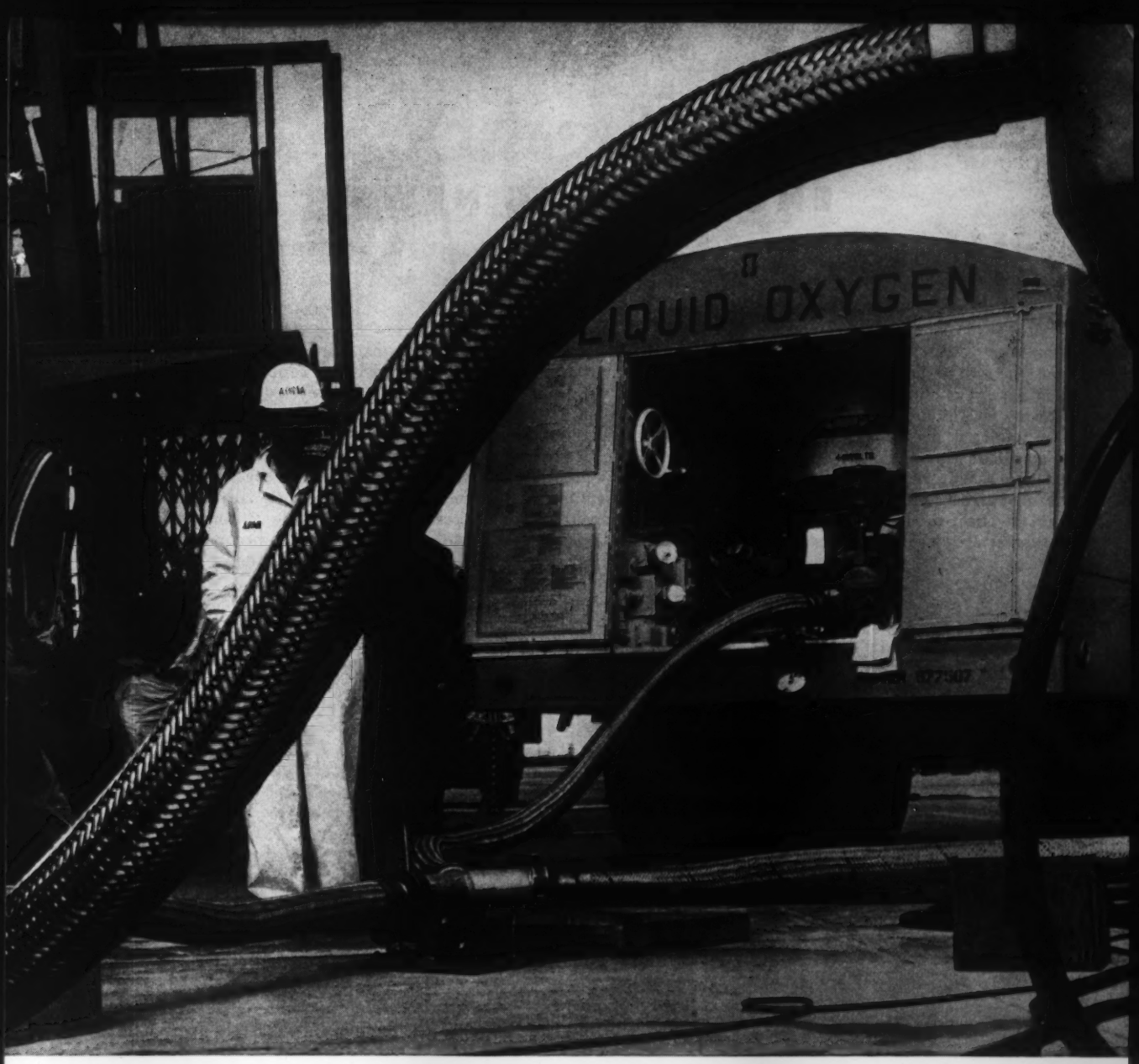
Subscription in United States, possessions, and Canada for home-addressed copies and copies not qualified under above rules: One year, $10. Single copies $1.00. Other countries: One year, $25. When requesting changes of address, etc., please allow four to six weeks for processing.

Published every other Thursday and copyrighted 1959 by The Penton Publishing Co., Penton Bldg., Cleveland 13, Ohio. Accepted as Controlled Circulation publication at Cleveland, Ohio.



THESE BIG TOUGH HOSE ASSEMBLIES SOAK UP THE SHOCK OF A SWING FROM TROPICAL HEAT TO −303°F IN SECONDS

It takes many heavy-duty flexible metal hose connections to feed liquid oxygen to a missile. In the photo above are four 3½" I.D. metal hose lines of stainless steel manufactured by Anaconda Metal Hose. They connect three tank trucks to the pumping station which fuels Jupiters at the Army's Redstone Arsenal. Similar hoses are used to make connections between the fueling masts and the missile itself, making it unnecessary to align piping precisely. As fuel masts are kicked off the missile at firing, the hose must be able to withstand rough treatment and hot exhaust gases, as well as the wide temperature fluctuations.

FREE TECHNICAL SERVICE. Whether you need big, heavy-duty flexible metal connectors for big, tough jobs or small-diameter flexible metal hose for small, tough jobs, Anaconda Metal Hose Division welcomes the opportunity to help you meet your problems of expansion and contraction, movement, vibration, corrosion, pressures, and temperatures. Equipped to work in stainless steel, Monel, and aluminum as well as other alloy steels and copper alloys, Anaconda specialists are constantly working with design engineers on flexible connector assemblies to meet new problems. For further information or engineering assistance, call your Anaconda Metal Hose representative or write: Anaconda Metal Hose Division, The American Brass Company, Waterbury 20, Conn. In Canada: Anaconda American Brass Ltd., New Toronto, Ontario. 59131

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METAL HOSE

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ENGINEERING NEWS

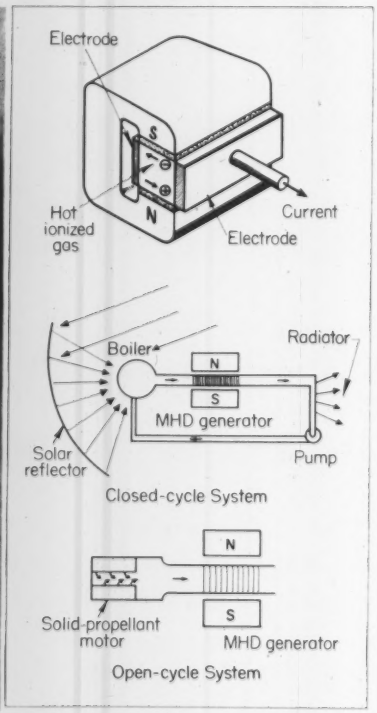
"Gas" Electricity—Promising New Power Source

NEW YORK—Achieving a major advance in electric-power generation, scientists at General Electric's Aerosciences Laboratory, Philadelphia, have produced electric current with a magnetohydrodynamic (MHD) generator. The new power source can operate at efficiencies higher than any heat-to-electricity process now known and has the added advantage of being free of moving parts. The principles involved have been known for some time, but translating the theory into hardware has been considered extremely difficult.

Like conventional methods of power generation, MHD is based on the movement of an electrical conductor through a magnetic field. But instead of the usual wire conductor (or wound rotor), MHD uses a high-temperature ionized gas. This accounts for its potentially high efficiency. According to present estimates, future MHD generators may convert 40 to 50 per cent of thermal energy into useful electrical energy, compared with a typical conversion rate of 35 per cent for conventional turbo-generators. To achieve these efficiencies, temperatures in the range of 5000 F are required.

MHD power is especially attractive for space applications, where it can be utilized in a closed-cycle system for continuous power, or in an open-cycle system for short bursts of power. In closed-cycle operation solar energy or a nuclear reaction would be used as the heat source, and the gaseous conductor would be continually re-circulated. The open-cycle version would use a monopropellant heat source. Small rocket motors now in use provide the power necessary to transmit a television image from a space vehicle on the moon.

GE's first success with the new power source occurred late last year, when scientists using an MHD generator produced one killowatt of electrical power for a period of five seconds. The time element has presumably been extended since then, and research now is aimed at reducing weight of the system and improving its reliability and efficiency. As for stationary power generation, GE scientists say the new technique will require considerable development before it threatens conventional equipment.



Heart of the MHD power generator is a molded quartz chamber mounted on a hollow graphite cylinder (left). Hot ionized gas is forced through the chamber where it passes between the poles of a magnet. The generator is normally enclosed in a 3-in. diameter steel casing. Schematic (top right) shows how voltage is generated within the conductive gas and drawn off by electrodes as the gas cuts through the magnetic field. The process readily lends itself to open or closed-cycle operation (lower right) and is ideally suited for space applications.

Engineering Takes a Back Seat In Co-ordinating New Products

AMA Survey Shows Function Performed Mainly by Marketing

NEW YORK—The product manager, a chief sales or marketing executive, or a staff member or department reporting to sales or marketing is responsible for co-ordination of product planning in 109 (43 per cent) of 252 companies surveyed by the American Management Association. In 41 per cent of the responding firms, this co-ordinating function is handled at the general management level, and in only 11 per cent, by the director of research and development or engineering.

The trend seems to be toward

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. . . Fluid Power news

REPORT NO. 12,105 NEW SECTION AND DRIVE IMPROVES PRODUCT

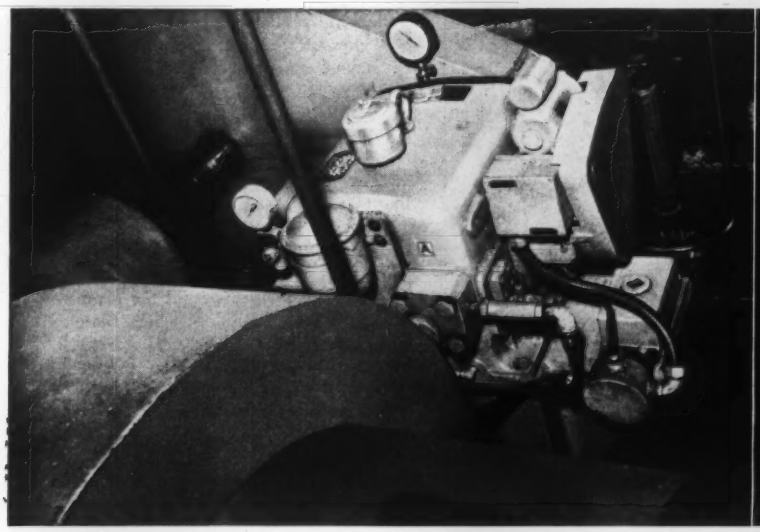
From Oilgear Application-Engineering Files

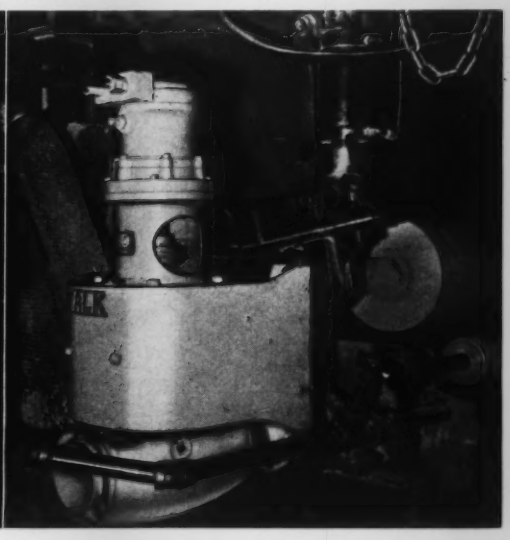
HOW OILGEAR HELPED SOLVE DRIVE PROBLEM FOR A NEW PAPER MACHINE SECTION

CUSTOMER: *A Large Midwestern Paper Manufacturer.*

DATA: To improve the finished surface of certain types and grades of paper, this manufacturer decided to insert a new sizing and smoothing section between existing sections of one of their paper machines. *Requirements: 1.* New section drive rpm must remain in same preset speed ratio with first dryer section roll regardless of over-all machine speed; allow precise, minutely controlled variation to increase or decrease wet sheet tension; hold constant speed within 6% regardless of increase or decrease of section roll pressures. *2.* Section drive to be inoperative at will without use of clutches . . . machine to operate with, or without the new section for dual purpose processing. *3.* Drive must be smooth, positive . . . without lag, shocks, or surges. *4.* Drive must fit within extremely limited, available space, and be direct-connected to new section sizing roll. *5.* Complete, individual control from a convenient, remote, push button station. *6.* Dependability, with a minimum of installation, or maintenance "downtime."

Note: A mechanical drive was considered, but space and control requirements would involve costly, major rebuilding of the entire machine.

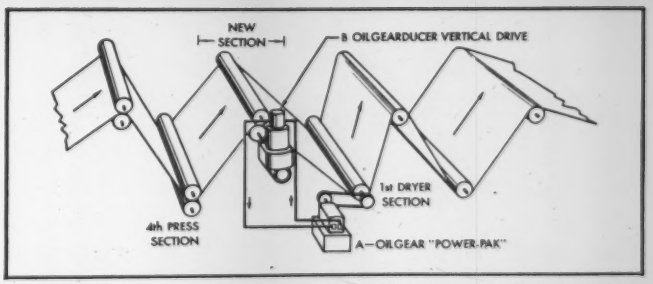




SOLUTION: Oilgear *Application-Engineers*, working in co-operation with company engineers, analyzed the speed, torque, control, and space limitations of this installation; and recommended an Oilgear "*Any-Speed*" drive consisting of a separate, heavy-duty, Oilgear pump and motor for the following reasons. *1.* An Oilgear Type "DE," Variable Displacement Pump with Electric Remote Control and Reservoir fitted into the very limited space available, and could easily be driven from the first dryer roll. *2.* A standard *Oilgearducer*—an Oilgear Constant Displacement Fluid Power Motor with integral right-angle gear reducer—could be direct-connected to the new section sizing roll. *3.* A simple pushbutton station for controlling this new section could be conveniently mounted on the opposite side of the paper machine. *Actual operation has proved that all initial requirements were either met or exceeded.*

Being a positive displacement drive, the direct-connected sizing roll rpm remains in the same speed ratio with the first dryer roll regardless of over-all machine speed. Original constant speed requirement—within 6%—is exceeded in actual operation . . . speed remains stable within 0.5% max. variation under full min. to max. load change. Two remote control station pushbuttons command the electric pilot control motor to increase or decrease pump displacement, changing the hydraulic motor speed and the section to machine ratio . . . precisely varying tension on the wet sheet. Section can be independently started and stopped from this station while the paper machine is running. Exact drive load and temperature are indicated. *In over four years of continuous, high-speed service, there has been no reported maintenance on this drive.*

This paper manufacturer has also Oilgear-equipped a laminator winder drive; the center winder on a super-calender stack; the unwind and rewind drives on another super-calender; five "wet-end" drives of another paper machine;



Oilgear Variable Displacement Pump (A) is driven from the first dryer section to keep the new sizing and smoothing press section speed in direct relation to the dryer section speed. Actual installation is shown in photo above, left. The small, geared-head pump control motor which changes pump stroke can be seen to the right of the pump. Controlled Fluid Power from the pump drives vertically mounted Oilgearducer (B), direct-connected to the sizing roll of the new section . . . as shown in photo above.

plus other applications in the mill and powerhouse. This user, like many others in all phases of all industry, knows that *for the lowest cost per year—it's Oilgear!* Additional drive application data is available—Bulletins 10600, 10051-G, and "News" 3, 5, 8—on request, without obligation.

For similar practical solutions to YOUR rotary or linear drive and control problems, call the factory-trained Oilgear Application-Engineer in your vicinity. Or write, stating your specific requirements, directly to . . .

THE OILGEAR COMPANY

Application-Engineered Controlled Motion Systems

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placing responsibility for new-product planning at the general management level: 61 per cent of the respondents said that best results can be obtained when product planners report to the president, general manager, or executive vice president.

One third of the companies responding to the survey have product planning committees which participate in decisions leading to the development of new products. These committees have sole responsibility for product planning in some firms; in others, the committee is a supplementary "board" for the product planner or planning department. In most cases a member of general management is chairman of the committee; in only 15 per cent of the firms is a research and development executive given this responsibility.

Other findings of the survey show that the best sources of product ideas are salesmen and their reports, with research and engineering staffs running a close second. Less important sources are customer suggestions, inquiries, and complaints; market research; and analyses of competitors' successes and failures.

The survey discloses that future product development will be concerned mainly with completing company lines, improving performance, building in uniqueness or identity, using new materials, lowering cost, and increasing reliability. Only five companies are looking for "more glamorous, appetizing, or luxurious products."

Outboard Motor Powers Minimum 'Copter

Counter-rotating rotors and handlebar controls simplify operation and maintenance of a new one-place helicopter. Instead of the usual "swashplate" mechanism with its assortment of bellcranks and pushrods, the minimum 'copter has a unique "tilting-head" arrangement, controlled by handlebars suspended in front of the open pilot's seat. Rotor lift and engine power are varied by twisting the left handlegrip, forward speed is controlled by pushing or pulling the handlebars. A pair of rudder pedals take care of left and right steering. The powerplant, a 60-hp Mercury outboard motor mounted behind the pilot, drives two coaxial counter-rotating rotors through a simple transmission. Torque is thus eliminated, and no tail rotor is needed. Designed by Bensen Helicopter Corp., Raleigh, N.C., the small craft will cruise for 100 miles at 60 mph (or double the distance with an oversize fuel tank). It's priced at $6995 ready to fly, or from $980 to $4500 in various stages of assembly.

Topics

Bringing home the torpedoes to a test range will be the task of a device to be developed by Vitro Laboratories, Silver Spring, Md., under a contract from the Navy. The retriever will be a self-propelled unit combined with a closed-circuit television system for spotting spent torpedoes. Deep-water lights will illuminate the TV camera's field of view, and an operator in a surface vessel will watch the screen. When he sights a torpedo, he will instruct the retriever to scoop it up.

• • •

Owners of too-compact cars may be cheered by the news that Carry-All Trailers Inc., Philadelphia, is producing utility trailers which can carry the overflow from either foreign or domestic models of small cars. Two trailers are available, both with heavy gage pressed steel bodies, double safety chains, rear reflectors, tail lights, and turn signals.

• • •

Fringe benefit for everybody is the "practical luxury" of a swimming pool in the Flick-Reedy Corp., Bensenville, Ill. Employees and their families are delighted to have their very own pool, and management is not at all unhappy about the savings it makes possible. The pool, an integral part of the plant fire protection system, cost less than half the price of a water storage tower; it saves $6000 on the annual water bill; and it provides a means of testing a filter which is under development.

• • •

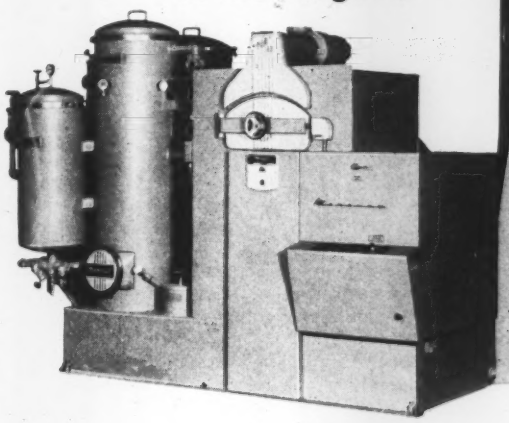
A fan in the oven may not be quite as antithetic as it seems. Circulation of air in an oven, reports a Michigan State University instructor, will either cook food faster at a given temperature or use only two thirds of the fuel required by ovens not equipped with fans.

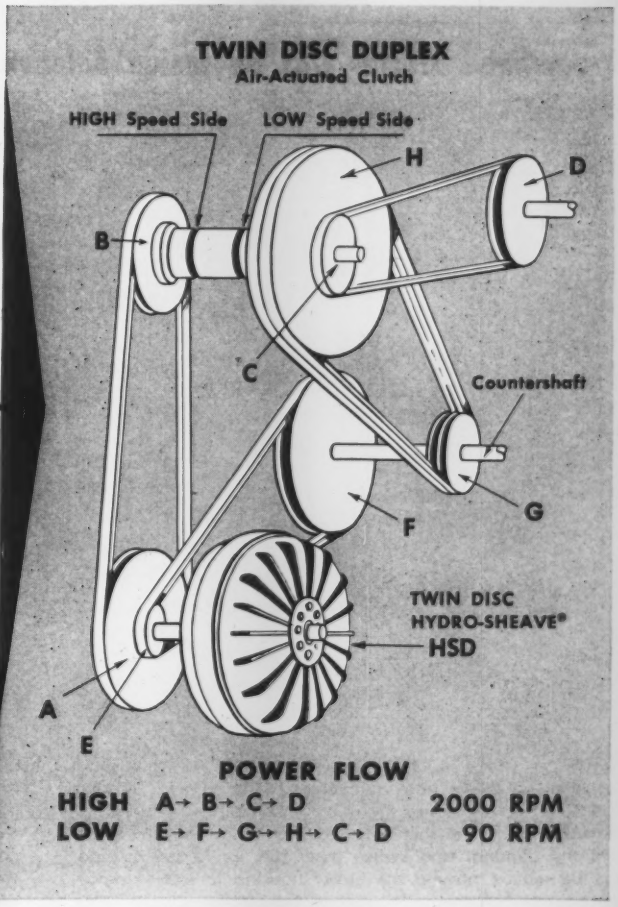
• • •

Wholesale launching will take place during the seven-day period from Nov. 16-22, which has been designated International Rocket Week. The United States will launch ten rockets, the highlight of the U. S. program for International Geophysical Co-operation—1959, which is a continuation of the IGY. NASA will send off two from Wallops Island, Va., and the Army Ballistics Research Lab will launch two from Ft. Churchill on Hudson's Bay and two more from Wallops Island. The Air Force Geophysics Research Directorate will get off three rockets, and the Naval Research Lab will account for the other one of the ten. All of them will measure conditions of the atmosphere.

Twin Disc helps solve tricky transmission problem

(and saves plenty of space in the bargain)





Designing the drive for a washer-extractor dry cleaning system is no simple matter. The reason, of course, is the wide variation in speed required for the two cycles—low for washing, high for extracting.

Engineers at Mercury Cleaning Systems, Inc. of Evanston, Illinois hit on a novel and effective solution to this problem in designing their new Model PER 50 Numatic cleaning unit. With power supplied by a 2 hp, 1750 rpm electric motor, a 3" Twin Disc Duplex Clutch was selected to effect the speed change. This tiny clutch is air-actuated to eliminate adjustment problems—wear take-up is automatic.

When one side of the clutch is engaged, the washer basket is driven at 30 rpm for the cleaning cycle. Engaging the other side produces 600 rpm for the spin-dry cycle.

This rapid acceleration—plus the heavy inertia of wet clothes—presented a high energy problem for the clutch and an overload problem for the motor. Both were solved by a Twin Disc 7.4S HYDRO-SHEAVE Drive. When the shift to the spin-dry cycle imposes a heavy overload, fluid "slip" within the coupling permits the motor to stay up to speed instead of being dragged down. The clutch is also able to engage much more quickly. Thus the energy load is dissipated within the fluid coupling instead of producing heat and resultant friction plate wear. The HYDRO-SHEAVE is furnished with quick-detachable mounting provision for a wide range of standard sheaves.

This installation is a good example of how Twin Disc friction and fluid drives give top performance in all types of industrial machinery. For details about the complete Twin Disc line, write for Bulletin 314. TWIN DISC CLUTCH COMPANY, Racine, Wisconsin; Hydraulic Division, Rockford, Illinois.

TWIN DISC

TWIN DISC

Friction Clutches and

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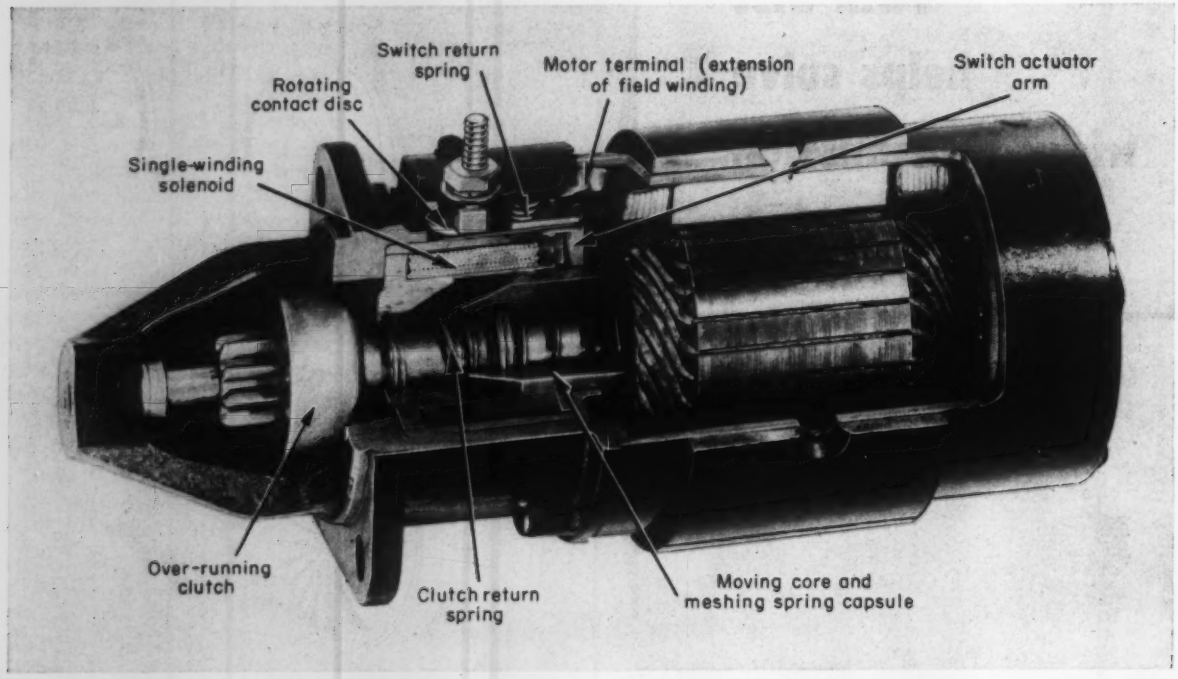
Streamlined Starter Has an Inside Solenoid



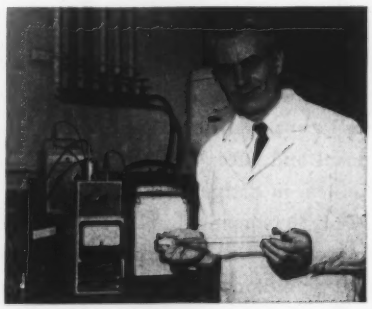
Mounting problems are minimized with a new starting motor—all of the usual piggy-back appendages have been moved inside. The shift solenoid is co-axial with the shaft, and the terminal and switch assembly, while still outside, can be moved around the motor housing to suit external-wiring requirements. Developed by Electric Autolite Co., Toledo, the streamlined starter has one further advantage: Its single-coil solenoid draws only 24 amp, vs. 70 amp for the two-coil arrangement in a typical 12-v automotive starter. Here's how the new device works: When the solenoid coil is energized the core forces clutch and pinion toward the ring gear. If pinion-gear teeth fail to mesh with ring-gear teeth, the meshing spring is compressed as the core continues to move forward. Just before the core completes its stroke, it trips the switch actuator arm, and the motor begins to rotate. As the pinion rotates into meshing alignment, it is accelerated into engagement by the compressed spring. When the solenoid is de-energized, the switch is opened by its return spring; core and clutch are returned to their rest position by the clutch return spring. Because all parts are enclosed in Autolite's starter, mechanical and environmental abuse are minimized.

Optimism Index: The Power of Negative Ions

Evidence is mounting that negative ions have an exhilarating effect on humans and provide relief from respiratory disease and burns. They may even offer protection against cancer and tumor growth.

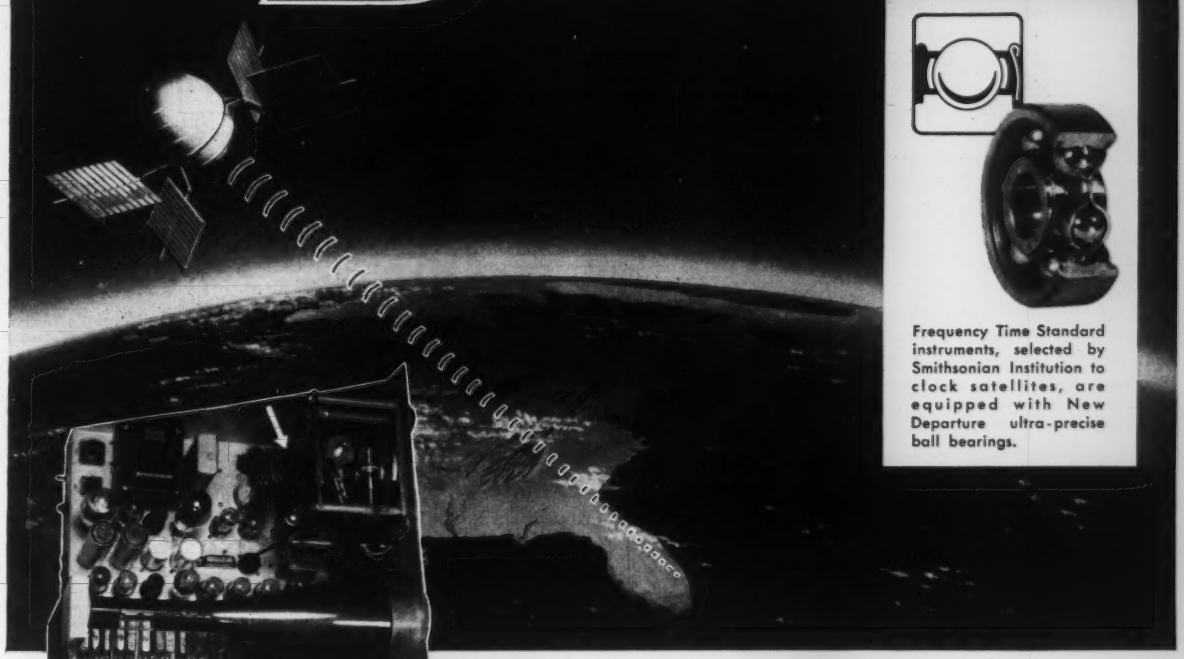
Westinghouse Electric Corp. is studying this phenomena because its ultraviolet lamps indirectly produce negative ions. Lamp energy photoelectrically ejects electrons from metals surrounding the lamps; the electrons attach themselves to air molecules and form negative ions. A recent unpublished report, by Westinghouse scientist Dr. Rudolph Nagy, summarizes findings by many researchers:

- Small negatively ionized particles in the air have beneficial effects; small positively ionized particles have harmful, or at least unpleasant, effects.
- Positive ions induce discomfort, ill temper, depression and fear, and (in extra-sensitive patients) attacks of asthma, hay fever, and high blood pressure. Negative ions induce feelings of well being, buoyancy and optimism.
- Asthma, sinusitis, rheumatic afflictions, fatigue, migraine headaches, and burns have all been relieved by negative-ion treatment.
- Exposing chickens to negative ions increases their weight and longevity; negatively ionizing air over wheat fields (on a regular basis) increases production by 29 to 40 per cent. Like yields were noted for other crops.



Experimental ultraviolet lamp produces sizable quantities of negative air ions. Apparatus collects and measures the number produced. Tests on how to produce the ions by simple methods have been in progress at Westinghouse for several years.

CASE HISTORIES



Frequency Time Standard instruments, selected by Smithsonian Institution to clock satellites, are equipped with New Departure ultra-precise ball bearings.

Photos: Courtesy Ernst Norman Laboratories and Bodine Electric Co.

Ultra Precise Ball Bearings Help "Clock" A Satellite!

CUSTOMER PROBLEM:

Require ultra-precise bearing design for Bodine electric motor used in satellite-tracking micro-clock. Bearings must provide uniformly low starting torque, precise location of rotor shaft and minimum maintenance, to help mechanism achieve time determinations to 0.001 second.

SOLUTION:

N/D Sales Engineers studied special bearing requirements, and recommended New Departure ultra-precise ball bearings. These ball bearings measured up to every requirement for micro-clock motors . . . thanks to New Departure's advanced equipment for research, development and production. N/D equipped micro-clocks, selected by the Smithsonian Institution, are operating in a dozen locations around the world, keeping track of vital satellite movements . . . to one milli-second and better!

If you're manufacturing or designing electric motors for any high precision applications, including instruments, why not call on New Departure? N/D engineering and research facilities are turning out the latest in high precision instrument ball bearings and advanced ball bearing designs. For more information write Department LS, New Departure Division, General Motors Corporation, Bristol, Conn.

NEW DEPARTURE

BALL BEARINGS

proved reliability you can build around

"Dry-Paint" Process Speeds Metal Finishing

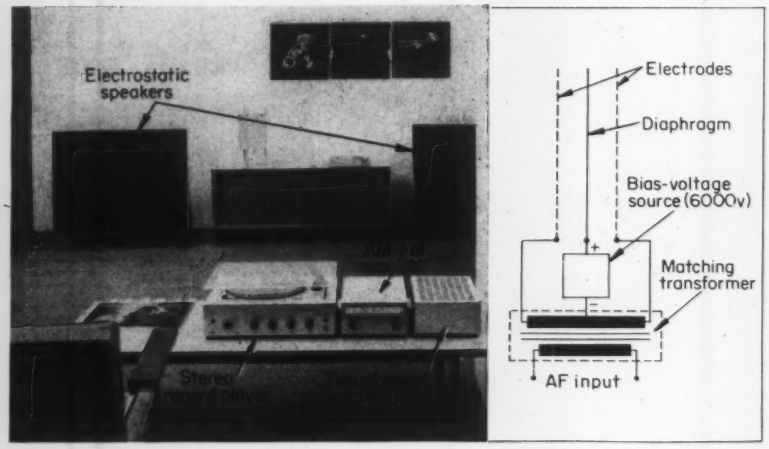
Three-Stage System Linked by One Solvent

DETROIT—In a matter of 15 minutes, racks of engine parts for one of Detroit's new compact cars are moved through a unique three-stage painting unit. The fast, new finishing system is considered a breakthrough in the state of the art. It offers a 50 per cent savings in time alone. Stage one on the new engine line is standard: Vapor degreasing based on trichlorethylene. Stage three is an example of a more recent development: Dip painting using non-flammable trichlorethylene as the thinner. Operation at near-boiling temperature causes the thinner to flash evaporate as soon as the part leaves the paint. This not only recovers the thinner for further use, but also eliminates a long, messy drip area and the hazards presented by flammable solvents. Stage two is also something new: A 700-gal phosphatizer (also based on trichlorethylene) that applies (by spray or dip) an almost imperceptible yet critical phosphate coating to steel, thereby improving the adhesion of paint and extending the corrosion resistance of the finished parts.

There's nothing especially new about phosphatizing; it's been a recognized part of metal finishing for years. But phosphate coatings applied via trichlorethylene solvents instead of conventional water solutions eliminate the need for 50 ft or more of a conveyor line (otherwise needed for drying) and, when tied in with trichlorethylene degreasing and painting units, eliminate several stages needed in conventional systems.

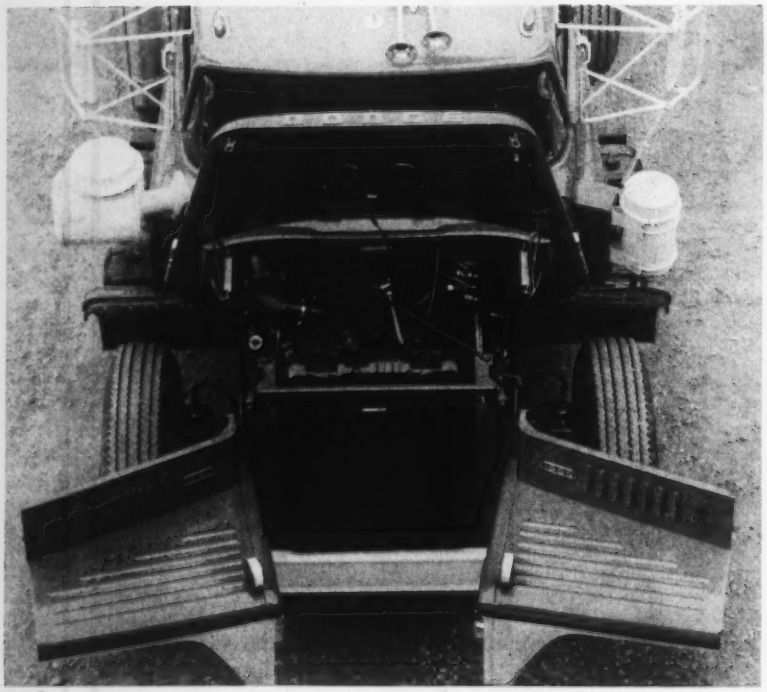
Demand for the one-solvent system was triggered by an automobile manufacturer. Chevy needed a system for steel parts that would apply flat, black paint in a one-coat, air-cure operation. Du Pont came up with the answer.

The new Du Pont process is applicable to metals other than steel, including aluminum, magnesium, and zinc. After completion of extensive field evaluation (of which the engine-line installation is a part) the Triclene Phosphatizing System will be available in 1960.



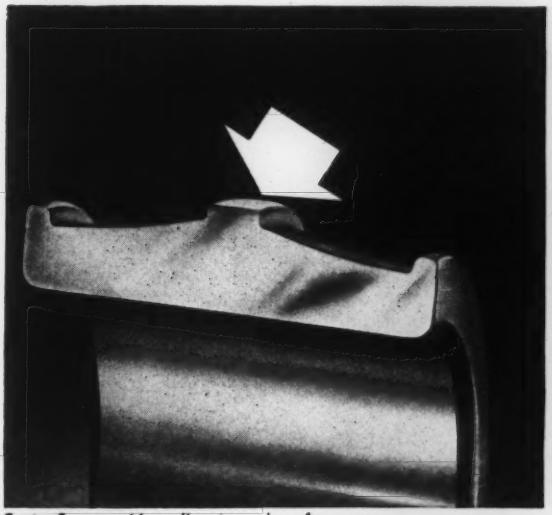
Old Principle—New Speaker

Electrostatic loudspeakers are staging a comeback in Germany, where they are being used in 45 to 18,000-cps hi-fi applications. Credited with exceptional treble response, the speakers were widely used 30 years ago. They declined in popularity because their key component—an electrically conductive foil diaphragm—could not be produced satisfactorily in large sizes. This restriction is now a thing of the past. Metal-coated plastic foil, oscillating between perforated sheet-metal plates, forms the heart of new electrostatic units. The speakers shown, designed by Max Braun, Frankfort, Main, are rated at 15 w. Dimensions are 33x30x12.5 in., including bias-voltage source and transformer.

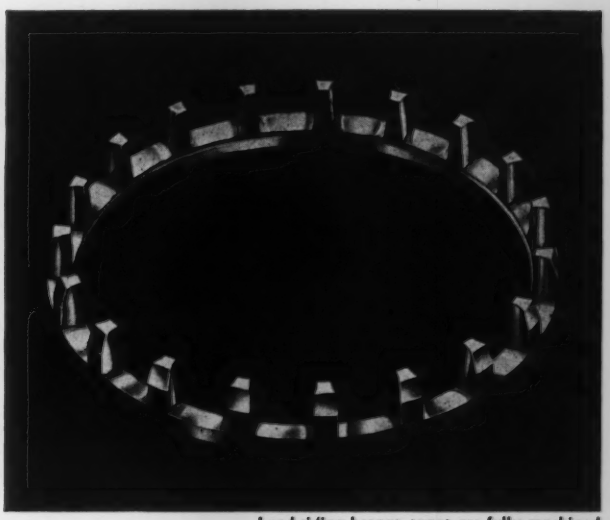


Swing-Out Fenders

Accessibility—a mechanic's dream—is engineered into the 1960 cab-forward Dodge trucks. Front fenders swing out 110 degrees to expose steering-gear linkage and housing, air-compressor drive belts, generator, and other components for service. The new cab design is reported to avoid the extra length of conventional models and the extra cost of tilt cabs.

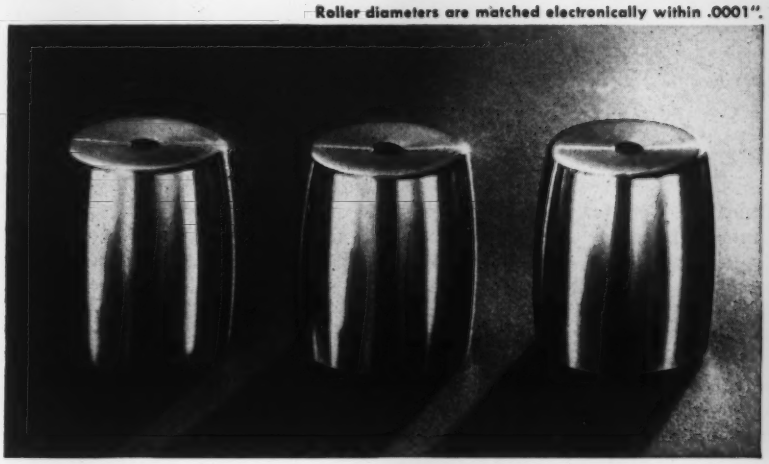


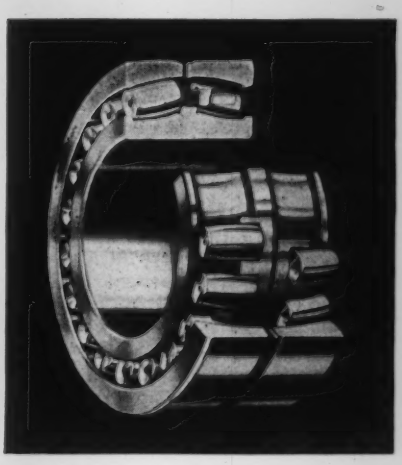
Center flange guides rollers to peak performance.



Land-riding bronze cages are fully machined.

Roller diameters are matched electronically within .0001".





Consider every design feature and you'll choose Torrington!

Torrington has compromised none of the operating design features of its Spherical Roller Bearing, because application experience has proved them essential to superior bearing performance.

There's no substitute for the stabilizing effect of the integral center guide flange. Torrington's asymmetrical roller seeks this flange under load. Skewing and stress concentrations are eliminated. Every roller carries its share of the load, for roller diameters are matched electronically within .0001" for even load distribution.

Rollers are precisely spaced by fully machined land-riding bronze cages that withstand even the high stresses of eccentric service. Two independent cages, one for each row, prevent roller drag and side stresses under thrust loads. Size-stabilized races prevent "growth" or change in dimension in service.

These features mean a cooler-running, longer-lasting bearing. When you buy bearings, look into *every* detail, and you'll choose Torrington. **The Torrington Company, South Bend 21, Ind.—and Torrington, Conn.**

TORRINGTON BEARINGS

District Offices and Distributors in Principal Cities of United States and Canada

Superior performance features of TORRINGTON SPHERICAL ROLLER BEARINGS:

- Integral guide flange for roller stability
- Asymmetrical rollers seek flange for positive guidance
- Electronically matched rollers
- Size-stabilized races
- Fully machined land-riding bronze cages
- Controlled internal clearances
- Even load distribution
- Inherent self-alignment
- Long service life

Send for new Spherical Roller Bearing Catalog No. 258

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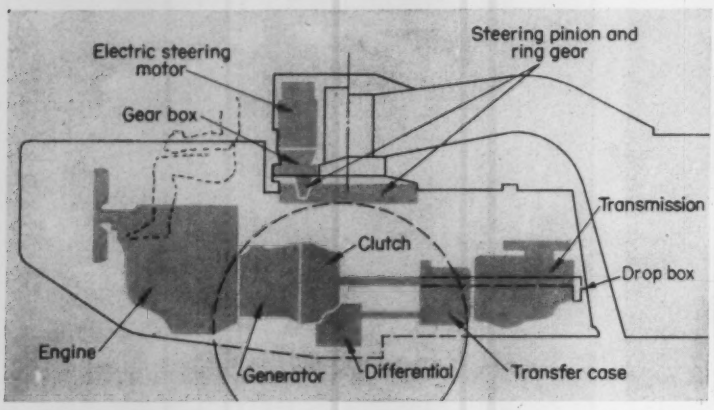
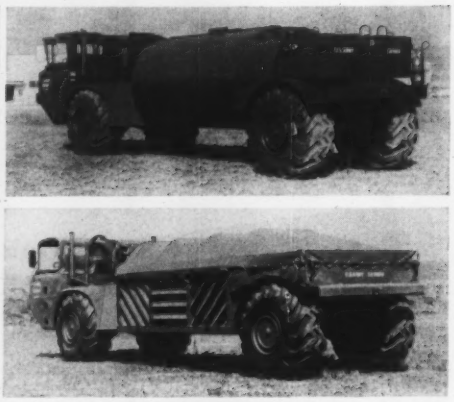
Triple-Threat Prime Mover May Fill Army's Transport Needs





An off-the-shelf earthmover, in slightly modified form, may end the Army's search for an all-purpose transporter. Interest in the off-the-road vehicle follows Army's realization that few major skirmishes have occurred on highways. Army brass are particularly impressed by a big vehicle called the "Goer." Designed by LeTourneau Westinghouse Co., Goer has articulated, wagon-type electric steering; high ground clearance; springless suspension; rugged simple power train; and 6-ft-tall rubber tires, all of which are common to modern earthmoving equipment. On or off-highway, or floating over rivers, Goer can carry 5000 gal. of fuel or 15 tons of cargo.

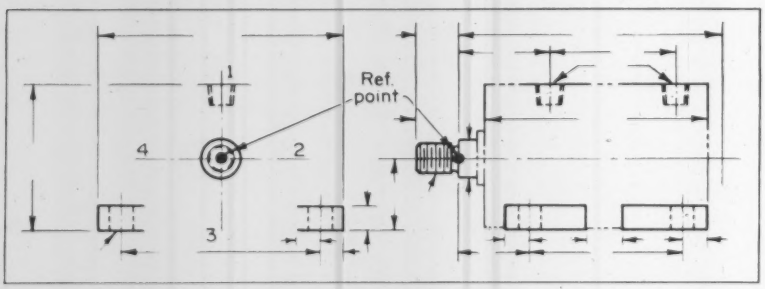
NFPA Settles on Cylinder Code

DETROIT—More progress is reported by National Fluid Power Association in a program aimed at clarifying fluid-power component identification. Members attending the Association's Fall Meeting on Oct. 28, approved a recommended code for dimensioning all pneumatic and hydraulic cylinders.

In effect, the code spells out a system of minimum dimensions keyed by uniform identification letters. It covers envelope dimensions, port sizes and locations, mounting dimensions (side, flange, rabbet, end, tie-rod, trunnion, etc.) and piston-rod connection dimensions. The new code comes complete with a simplified pattern of dimension presentation (see diagram) which, for the user, should reduce application design time and minimize the possibility of making dimensional errors.

Adoption of the new standard followed a thorough study of dimensioning practices used throughout the industry. It parallels a similar code on cylinder and rod sizes, established earlier this year by NFPA (MACHINE DESIGN, June 11, 1959, Page 10).

Next project likely to appear in NFPA's standardization program is a massive glossary of fluid-power terminology. The "bible" has been in the works for several years and is now almost ready for approval.



Basic dimensioning system recommended by NFPA for fluid-power cylinders is illustrated by this composite drawing. Key to the system is the fixed reference point, located at the force-transfer point on the piston rod. From this reference, cylinder and mounting dimensions can be determined with minimum supplementary additions or subtractions. A two-letter code will designate dimensions.

Mathematical Platform Forms Base for New Inertial System

Digital Computer Becomes Guidance Gimbal

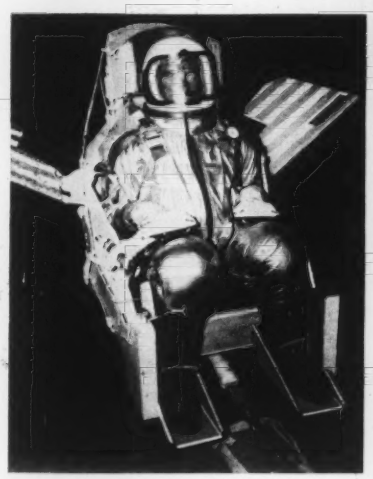
LONG ISLAND CITY, N. Y.—Radical system for inertial guidance of aircraft and missiles will have all gyros and accelerometers strapped down. The system is being developed by Ford Instrument Co., Division of Sperry Rand Corp., for the U. S. Air Force.

In conventional systems, gyros and accelerometers must be allowed complete freedom of motion relative to the body of the vehicle. This requires a "stable platform" inside a nest of free-swinging gimbal rings, in turn attached to a heavy base. The gyros effectively force the accelerometers to conform to predetermined orientation, independent of changes in heading, pitch or roll.

The new system, designated AJN-7, will work differently. The gyros will exercise no control over the accelerometers. Gyros will simply measure deviation of the vehicle from its initial orientation and accelerometers will be permitted to follow any movement of the vehicle. Signals from the instruments will be fed into a digital computer which will integrate the data and provide continuous information on speed,

direction and location.

Use of the digital computer will simplify the system. The gimbal structure of conventional systems requires a great deal of unobstructed space for motion, and parts must be built to close tolerances. Usually, the more accurate navigating systems depend on very bulky gimbal systems. The AJN-7 relegates the entire problem to a compact digital computer.



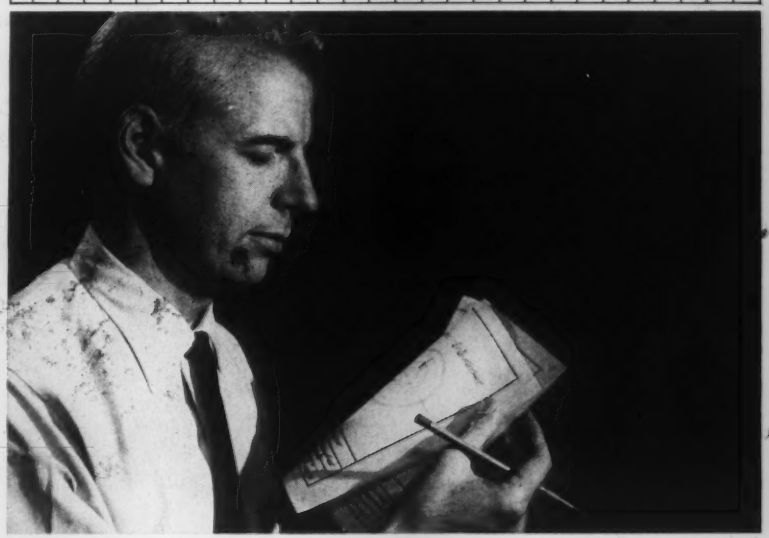
Flyable Seat for X-15

Stabilizing fins added to the pilot-ejection system in North American's X-15 research plane will help improve survival odds in event of peak-performance escape (Mach-4; 120,000 ft). Made of light-weight aluminum honeycomb, the fins are designed to prevent uncontrolled tumbling of the seat before deceleration chutes open. Special honeycomb used in fabricating the fins was developed by Hexcel Products Inc., Berkeley, Calif.

Government Upgrades Engineers

WASHINGTON, D.C.—Some engineers and scientists employed by the Defense Dept. will get a pay raise, thanks to a bill recently approved by Congress, authorizing reclassification of jobs relating to the national defense. Number of so-called P. L. 313 positions will be increased by about one third to a total of 450. These jobs are in the $12,500 to $19,000 range. Also, 69 positions in grades 16, 17, and 18 ($14,190 to $17,500) will be added to the present allocation of 303.

DRAFTING TRENDS



Compare the true vellum feel! This new sepia feels and handles like the best vellums. You can make this comparison test yourself—write for the Vapo-Vel Portfolio offered below.

A sepia intermediate that handles like the best vellum

Intermediates have been used for years to speed drafting and alter original drawings. But up to now most have had drawbacks such as . . . cost, premature spoilage, inconsistency in print image and variable drafting qualities.

For many years, Frederick Post Company has had an excellent and widely used diazotype intermediate, Vapo-Vel. Now, through intensive laboratory and field research, a dramatically-improved, Vapo-Vel sepia-tone vellum is available.

New standard for intermediates

New POST Vapo-Vel 209 combines every important feature you've been looking for in a transparentized paper base print—top drafting qualities, superior shelf-life and filing characteristics, and outstanding printback speed. It is produced under POST "Control Coated" conditions to assure consistently uniform prints.

To the man on the board, this newly improved Vapo-Vel is a real find. It has all the drawing and transparency features of a top-notch vellum, even that crisp vellum "feel." Vapo-Vel's easy-to-read dark brown image and outstanding transparency eliminates eyestrain in modification work on the back of reverse-reading prints. The surface takes pencil well, and inks without feathering. Pencil erasing characteristics of this strong 100% rag premium paper are truly outstanding, while eradication of print images is easily accomplished.

New test kit available

Write today for the POST Vapo-Vel Portfolio. It contains sample prints to examine and test, a Print Characteristics Checklist, a Data Sheet and a copy of POST's popular booklet "11 Ways to Save Drafting Time." To keep up-to-date with the latest, just write Frederick Post Company, 3652 North Avondale Avenue, Chicago 18, Illinois.

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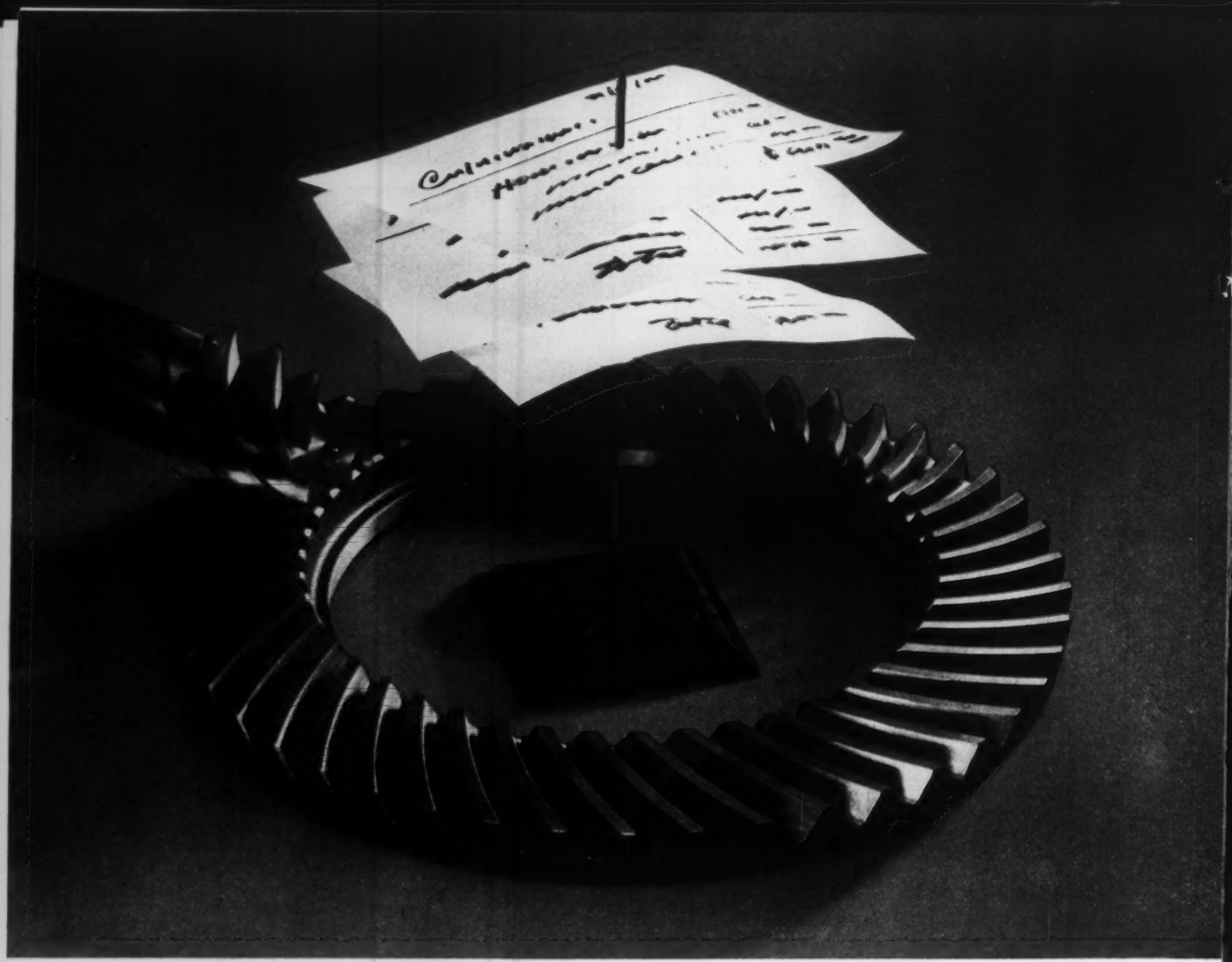
SENSITIZED PAPERS & CLOTHS • TRACING & DRAWING MEDIUMS • DRAWING INSTRUMENTS & SLIDE RULES
ENGINEERING EQUIPMENT & DRAFTING SUPPLIES • FIELD EQUIPMENT & DRAFTING FURNITURE



GEAR BILLS come in "THREES"

No matter where you buy them, every gear order automatically involves three costs.

1. *The initial cost of the gears themselves*
2. *The cost of installation*
3. *The cost of service*

The second two bills—installation and service—can run much higher than the initial purchase price. That is particularly apt to be true where corners are cut to make the purchase price low.

We always strive to produce "Double Diamond" Gears at a low initial price. Even more important, they are made to standards which lower the *total* gear cost—purchase price *plus* installation *plus* service. It is *that* figure that interests us most. If it interests you, too, you may find it worth your while to consult a "Double Diamond" engineer next time you're wanting gears of the many types we make.

EATON

AUTOMOTIVE GEAR DIVISION
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RICHMOND, INDIANA

GEARS FOR AUTOMOTIVE, FARM EQUIPMENT AND GENERAL INDUSTRIAL APPLICATIONS
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CIRCLE ITEM NUMBERS—Throughout the magazine, each advertisement carries an Item Number for use in requesting further information. All product descriptions, announcements and Helpful Literature items are also numbered, and for greater convenience are indexed below by Item Numbers.

EDITORIAL CLIPSHEETS—So you won't have to "clip" this issue, we'll be glad to send a personal copy of any article as long as the supply lasts. Just fill in the page number and title of article in the place provided on the Yellow Card.

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IT'S ICE-SLICK

Won't Stick at 30° Below

Try C/R K-400 Cups for Smoother Power Cycles

Any time you face the problem of reducing cylinder cup breakaway or sliding friction, chattering or freezing, come see us. We're reasonably certain that Chicago Rawhide's Sirvis Leather K-400 cups can help you. Their specialty is easy sliding — particularly in vacuum cylinders at sub-zero temperatures and in pneumatic cylinders at ambient temperatures and low pressures. Tests show a 50% reduction in breakaway and sliding friction over standard leather cups at ambient temperatures . . . and these K-400 cups are functioning beautifully in applications at -30° F. In another test, C/R Sirvis K-400 cups were run well over one million cycles at 20" of vacuum with negligible leakage and wear.

So if you are trying to design a new, smooth-working, low-friction pneumatic cylinder — or take the bugs out of an old one — jot down C/R K-400 cups and call us.

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C/R PRODUCTS: C/R Shaft & End Face Seals • Sirvene (synthetic rubber) molded pliable parts • C/R Non-metallic gears

C/R

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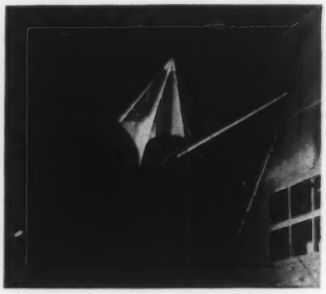
slow ride home for manned satellites

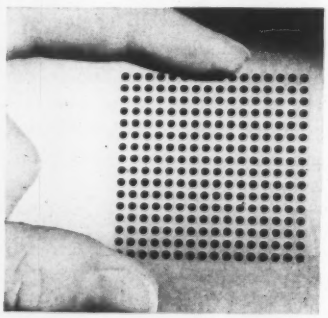


Foil-thin re-entry "kites"—hardly more substantial than aircraft of the rag-wing-and-wire era—may make things more comfortable for returning astronauts. Looking for a second round of more sophisticated spacecraft, NASA is checking performance of winged re-entry vehicles as replacements for the present high-drag, no-lift Mercury configuration. Object is to return a capsule with less rigorous decelerating force on the pilot (8g is about the acceptable limit). To get around a serious problem—instability of winged space vehicles during launch—NASA proposes a wire cloth and plastic glider that will be packed in a small container during takeoff and orbital flight. Ejected and inflated at re-entry, the glider will give a flat, controlled trajectory to a returning capsule.

information please

Snowballing masses of available technical information call for the creation of "information" scientists on the same corporate level as technical scientists and researchers, according to John C. Green, Director of Technical Services, U. S. Dept. of Commerce. Speaking before the 15th annual National Electronics Conference in Chicago, he pointed out that the Russians are producing abstracts of technical articles from world-wide sources within four to seven months after the material originally appears, and they may soon cut this time lapse in half. Mr. Green points out that American industry is not yet "mining its information resources" effectively. He said two sources of information should be exploited more fully: 1. Several companies, large and small, could pool research findings through licensing agreements. 2. Reports being issued by Government Agencies at the rate of 1000 per month contain a warehouse of valuable information that industry should use more effectively.

memories get thinner

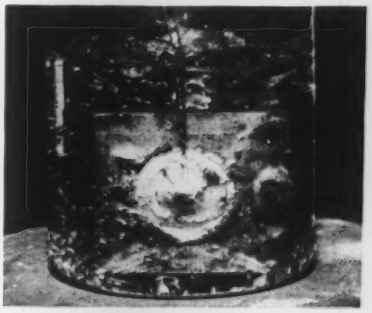


First successful magnetic-film memory in a digital computer has been in operation since July 1959. Developed by MIT's Lincoln Laboratory, Lexington, Mass., the film memory has four advantages over core memories: Faster cycle time, lower power dissipation, greater compactness, and simpler fabrication. Memory elements are circular spots of Permalloy film (82 per cent nickel, 18 per cent iron) 750 angstroms thick, evaporated on a thin glass substrate. Each element is 1.6 mm in diam; center-to-center spacing is 2.5 mm. The memory has a capacity of 32 ten-bit words. Developed for a TX-2 digital computer, the memory and computer are both being studied as experimental prototypes for larger units.

British engineers head for the colonies

No wonder our engineers can be lured to North America, concludes the British Engineers' Guild. The Guild has recently completed a salary survey and forecasts a steady decrease in British engineering efficiency unless something is done to boost earnings. Fifty per cent of mechanical, civil, and electrical engineers queried earned less than $3500 during fiscal 1955-56. Thirty per cent took home less than $3000 and only 25 per cent made more than $4500. Although incomes have improved since then, there is still a long way to go. Unless something drastic is done, the Guild believes the problem facing British industry—competing with American salary offers—will get worse.

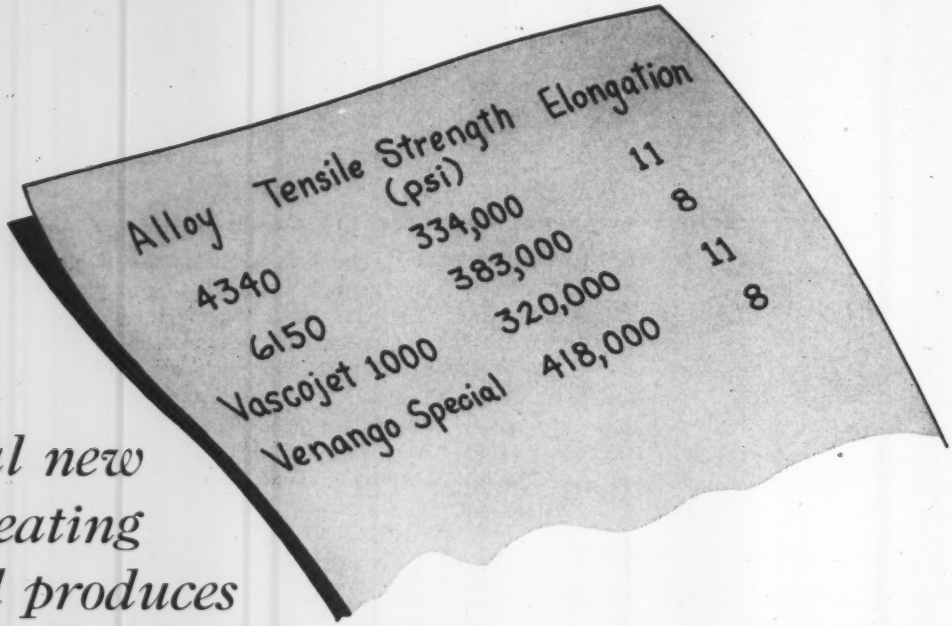
hot bath no strain on this gage



Boiling water and strain gages—normally incompatible—can be mixed readily and indefinitely with a new gage-mounting technique developed by Battelle Memorial Institute. It's done by soldering a brass blister, about the size of a quarter, over the strain gage. Lead wires are protected by a stainless-steel sheath. According to instrumentation specialist Nelson A. Crites, the technique will allow the gage to measure strain accurately for an indefinite period under boiling water. In contrast, chemical coatings may survive for 24 hours. Battelle developed the protective pods while studying water-cooled rolling mills and engine cylinders.

end of the road for the steel muffler

Cast-aluminum mufflers designed to outlive an automobile will be on the market this year. A combined effort by Reynolds Metals Co. and Centr-O-Cast Engineering Co., Detroit, has finally resulted in a corrosion-proof answer to a particularly thorny automotive problem. Weighing 40 per cent less than a steel muffler, the aluminum version beats steel on almost every count: It heats up about seven times faster, to effectively minimize cold-start condensation; it stays at least 300 deg cooler during operation; it can be formed to fit any peculiar body-frame configuration, eliminating the need for multiple muffling units; and it is virtually immune to external damage. Cast in two halves and bolted together, it can easily be inspected and repaired, if necessary, instead of being replaced. Photo compares the aluminum muffler, center, with two steel units after equally grueling road tests.



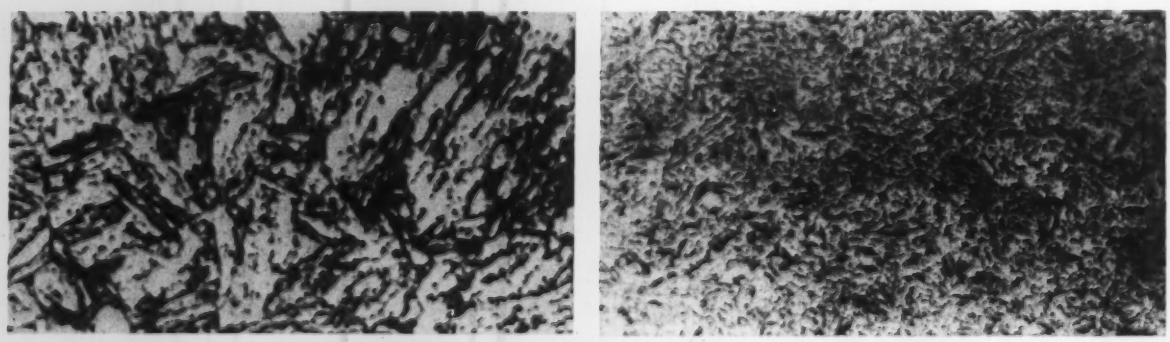
Radical new heat-treating method produces

Superstrong steels

. . . and they're ductile!

SIMULTANEOUS GAINS in both strength and ductility of alloys—up to 60 per cent with some materials—are claimed for a new heat-treating process. It's said to boost all physical properties that are significant to the designer, rather than just improving one or two at the expense of the others. Developed by William J. Bassett, president, Research Development Corp. of America, Gardena, Calif., the process can be closely controlled, and almost any desired combination of alloy properties can be achieved.

Traditionally, when a metal part requires extra strength, the designer has two choices: He can specify that the part be heat treated, or he can look for a substitute alloy. While these approaches have proved satisfactory, they sometimes created new problems as serious as those they solved. Often, an existing al-



Microphotographs of 4340 Alloy (magnification—625 X) show coarse grain resulting from standard heat treating, left. The Bassett process rearranges and highly refines grain structure, right. Smaller and more equal sized grains and more compact and homogeneous grain configuration are believed the key to improved alloy properties.

Here's What the Bassett Process Does for Alloys*

Alloy	Tensile Strength (psi)	Yield Strength (psi)	Elongation (per cent)	Reduction of Area (per cent)
4037	280,000 (240,000)	245,000 (215,000)	11 (7)	35 (35)
4130	260,000 (235,000)	230,000 (220,000)	11 (10)	41 (40)
4140	325,000 (260,000)	260,000 (220,000)	12 (8)	32 (42)
4340	334,000 (287,000)	270,000 (270,000)	11 (11)	32 (38)
6150; 0.53% C	383,000 (298,000)	310,000 (263,000)	8 (1)	25 (42)
6152; 0.49% C	361,000 (280,000)	295,000 (245,000)	9 (9)	27 (38)
Thermold J†	354,000 (290,000)	290,000 (237,000)	6 (2.1)	22 (14.7)
Vascojet 1000§	320,000 (311,000)	255,000 (241,000)	11 (3.3)	38 (7)
Venango Special	418,000 (358,000)	352,000 (325,000)	8 (6)	21 (24)
A-286	174,000 (140,000)	..... (94,000)	25 (15)	55 (50)
410 Stainless Steel	234,000 (190,000)	162,000 (145,000)	12 (15)	36 (4)
431 Stainless Steel	242,000 (180,000)	180,000 (125,000)	17 (17)	57 (50)
AMS 6434	311,000 (260,000)	220,000 (220,000)	11 (6)	35 ..

*Standard heat treatment data in parenthesis. †Unimach #2. §Unimach #1.

loy would be ideal if one of its factors—e.g., tensile strength, elongation, or reduction of area—could be improved without sacrificing the others. This is not always practical with conventional heat treatment. Tempering at high temperatures, for example, improves ductility but decreases tensile strength.

Avenues of improving heat treatment are all considered well explored. But this is not true, says Bassett. Physical limits for existing alloys can be increased well beyond present book standards. The Bassett process, he believes, helps a metal realize its true potential strength.

What It Does

Process details haven't been released—RDCA has filed for patents—but the company will discuss the effect of the process on an alloy. Primarily, it achieves a smaller, more homogeneous grain structure. This is the vital factor in the advancement, for iron and other metals are remarkably strong in crystal form. Most scientists believe the strength of a perfect crystal is due to the way atoms are uniformly packed into crystal lattices.

With standard heat-treating methods, alloy grain becomes heterogeneous in structure and crystal formation assumes a random alignment. In some cases, grains form large groups with definite lines of demarcation, resembling needle-like formations of various sizes with little directional orientation.

In the high tensile ranges, such grains are physically antagonistic to one another—in fact, they serve as stress raisers. Consequently, fracture is very apt to occur under load.

When metal is heat treated by the Bassett process, grains are more highly refined, smaller, and of equal size, and the configuration is more compact and homogeneous. Stresses or strains are evenly distributed. This gives an alloy greater plasticity, toughness, and ductility, even in the extremely high hardness ranges obtained by the process, says RDCA.

Crystallographic studies conducted with an electron microscope at 29,000 diameters have substantiated this theory. Ultrafine and uniform grains are apparent, as is the absence of heterogeneous-sized grains which can develop into points of stress concentration and weak spots.

Some of the Results

According to Bassett, chrome die steels can now be boosted to over 325,000 psi, with approximately 13.3 per cent elongation and 37.4 per cent reduction of area. By comparison, present properties of these steels are 280,000 psi, 7 per cent elongation, and 25 per cent reduction of area.

Stainless steel can be processed to 305-310,000 psi with all the good useable properties retained—and with corrosion resistance improved because of the excellent dispersion of carbides. Notch sensitivities of many alloys, titanium and stainless steels in particular, are also improved.

The process is important to titanium users in several ways. Many manufacturers have real difficulty with this glamour metal, since it is not easily heat treated. Failure is usually due to poor reproducibility of heat treatment and inability of the metal to meet strength requirements. The Bassett process, claims the developer, provides more strength (240,000 psi), with an elongation of 11.5 per cent. It guarantees reproducibility of heat treatment and greatly improves machinability of titanium. Similar improvements in physical properties of other glamour metals have also been noted.

What's the Future?

RDCA, now awaiting finalization of patent proceedings, intends to license the process to industry. Although present results, for the most part, are based on research and development studies, the thousands of tests conducted have proved extremely consistent. Company executives are confident the process will produce metal with ultimate tensile strengths of 1 million psi—perhaps within the next year or two. This will be done by matching the method to new alloys that are now under development.

Bucket seats in the rear with the transmission for an arm rest change the interior of the new Porsche. Mechanically, the '60 line is changed to include a 102-hp model that boasts a top speed of 112 mph and fuel performance of 28 mpg (at slower speeds). The same four-cylinder, air-cooled pancake engine is used (formerly 88 hp @ 5000 rpm), but compression ratio is boosted from 8.5:1 to 9:1. A new carburetor, new cylinder head with larger induction ports, and larger intake valves make the difference.

Taking a tip from Detroit,

Imports Begin Model

A RECENT COUNT by the Commerce Dept. discloses approximately 80 different makes of foreign automobiles available in the U. S. Perhaps the most unusual fact about the flood of imports is that few of the 80 cars display any marked similarity. Engine arrangements, for example, cover the spectrum: There are single-cylinder engines, two-cylinder engines, two-cylinder horizontally opposed, four-cylinder

Changeovers

in-line, four-cylinder opposed, the conventional straight six, V-8s, and V-12s. In addition to these somewhat old-fashioned mills there are V-4s, V-6s, and an in-line three.

Transmissions also run the gauntlet, from belt drives to electromagnetic clutches. Frames may be a maze of steel tubing or a simple tuning-fork configuration. Suspensions show the same spirit of variety,

(*Continued on Page 29*)

New addition to the midget-sport-coupe field is the Goggomobil Isar S 35—a direct descendant of the Isar 700 sedan. The coupe uses a souped-up version of the sedan's two-cylinder, air-cooled pancake engine. Compression ratio is up from 7.2:1 to 9.2:1, and the new engine develops 38 hp at 5700 rpm. Top speed is 84 mph; fuel consumption, 41 mpg. The car is 125 in. long, 48 in. high, and weighs just 1350 lb.

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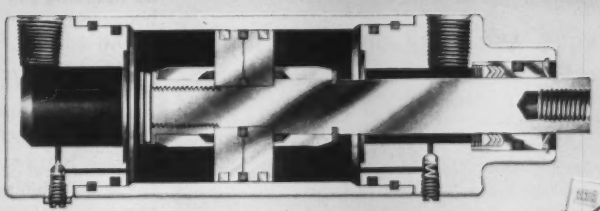

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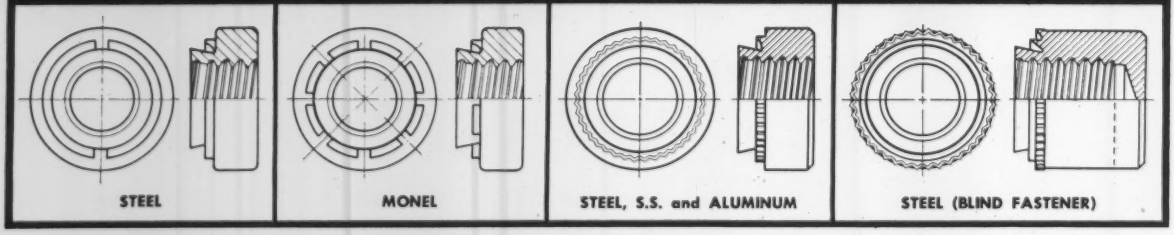

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Circle 415 on Page 19

range from complex swing-axle arrangements (which appear on some of the least expensive models), to straight steel axle shafts with only the suggestion of springing.

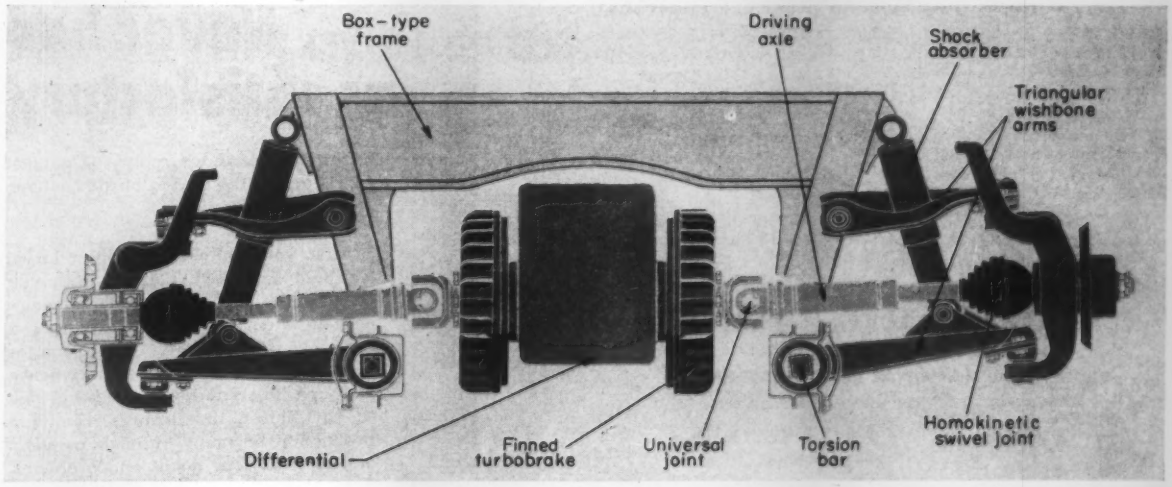
To the average American buyer, who seems to have lost interest in studying basic mechanics of his relatively few domestic varieties, foreign engineering features may appear increasingly obscure. And the picture isn't clearing up any, because foreign-car builders are picking up some American habits: First signs of an annual model changeover are beginning to appear. If keeping track of carburetors in Detroit models is confusing, sorting out the myriad of changes possible in 80 radically different foreign makes will really tax the imagination.

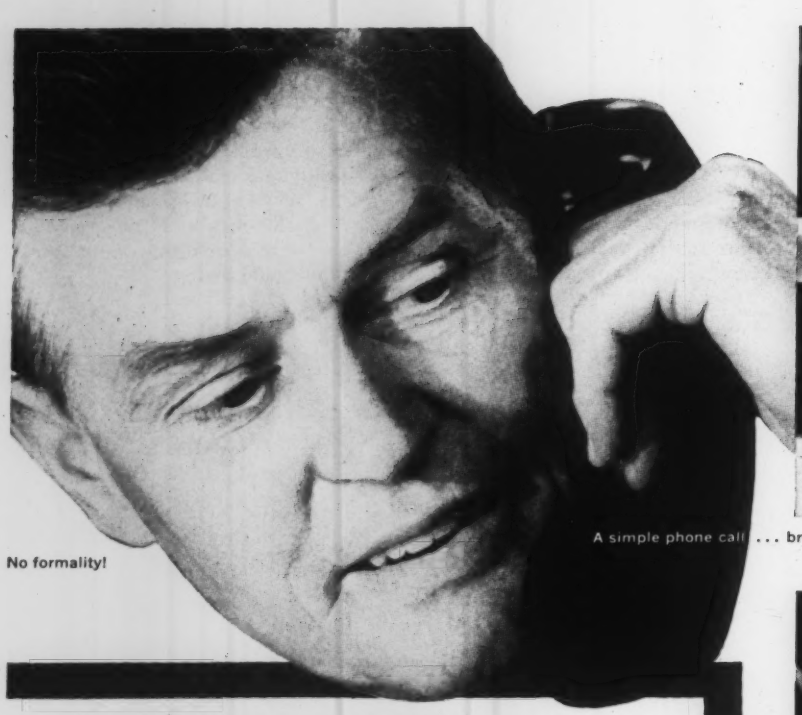
A small selection of overseas '60s show what's involved in a continental model change.

"Not a spartanic driving machine, but a modern automobile," is the description GM gives its new Opel 1200. The car resembles the more powerful Rekord line, but is designed to capture part of Volkswagen's big market. Opel's front-mounted conventional four-cylinder engine develops 46 hp @ 4700 rpm (VW: 36 hp @ 3700 rpm); wheelbase is 100 in. (VW: 94.5 in.), and empty weight is 2000 lb (VW: 1610 lb.) Germans like Opel's American styling.

Two-cylinder, air-cooled pancake engine, rear mounted, powers the new BMW 700 sedan. The car is made by the builders of Isetta, but has conventional side doors and will seat four in relative comfort. It has a 12-V electrical system, optional automatic clutch, and independent four-wheel suspension (coil springs; hydraulic shocks). Wheelbase is 83.5 in.; overall length, 139 in. The car's 35-hp engine provides a top speed of 75 mph.

Pretentious front suspension, adopted from the rear of Mercedes racing cars, gives the new DKW Junior a proud engineering feature. The car is front-wheel driven by an in-line three-cylinder engine; will hit 72 mph and average 32 mpg on 39 hp. The unique valveless engine has only seven moving parts—three connecting rods, three pistons, and a crankshaft. Junior seats four, has an 85½-in. wheelbase, and is 155 in. long.





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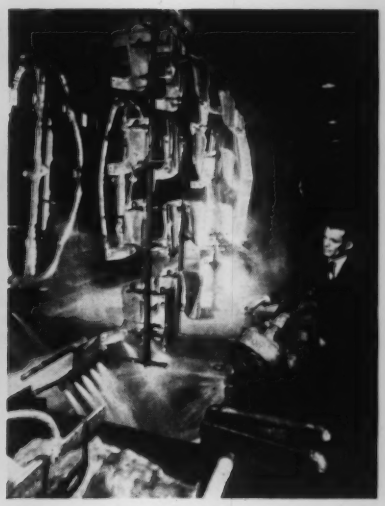

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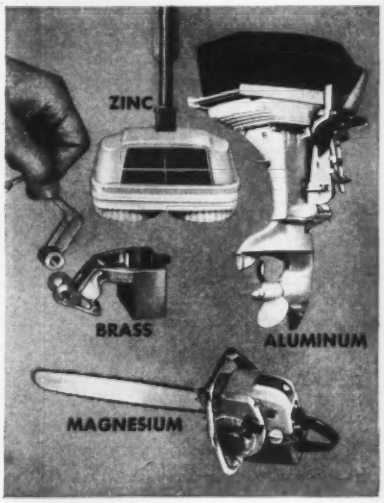

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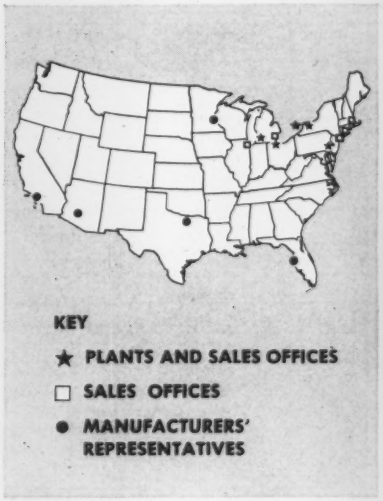

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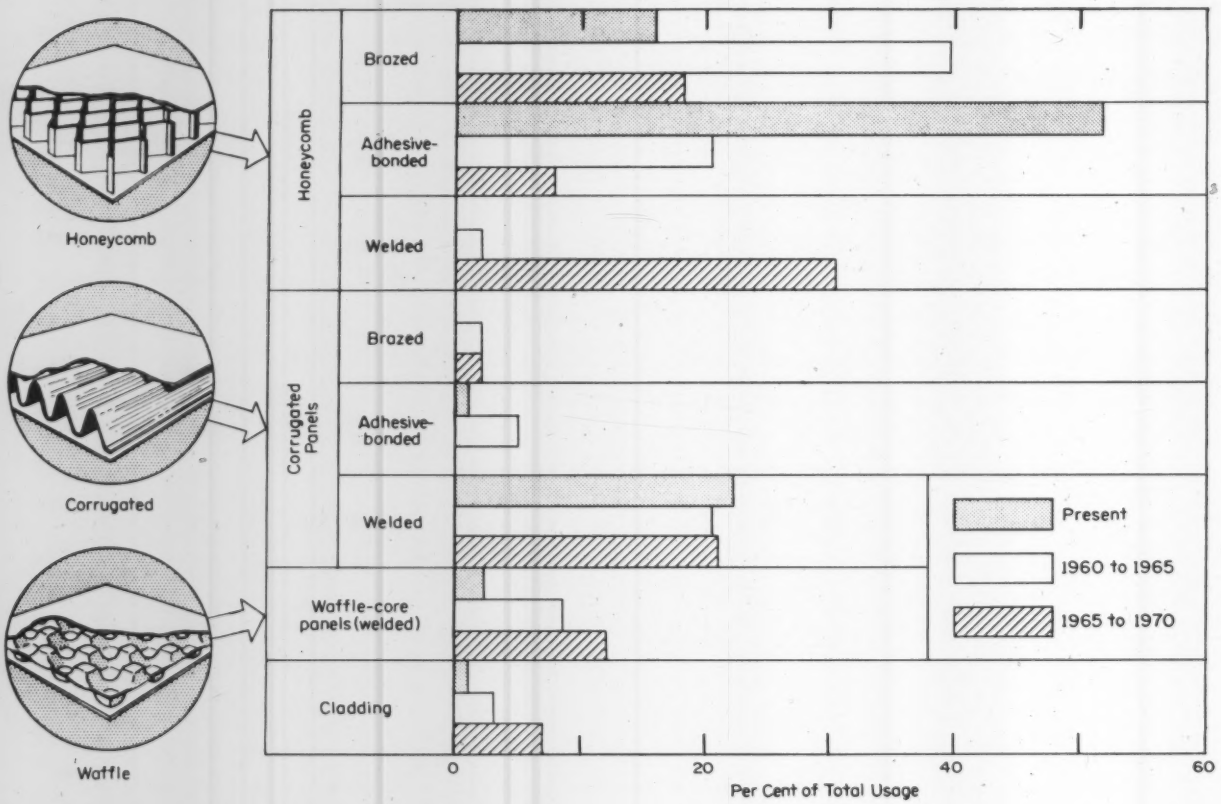
Circle 416 on Page 19

More strength . . . less weight . . . higher temperature tolerance . . . how do we satisfy all these demands in one structure? One promising answer: Sandwich panels. On World War II aircraft such built-up panels solved many weight and strength problems. Missile and hypersonic aircraft development is now taking the the place of the big jet aircraft push of the 50's; it will have a big part in shaping . . .

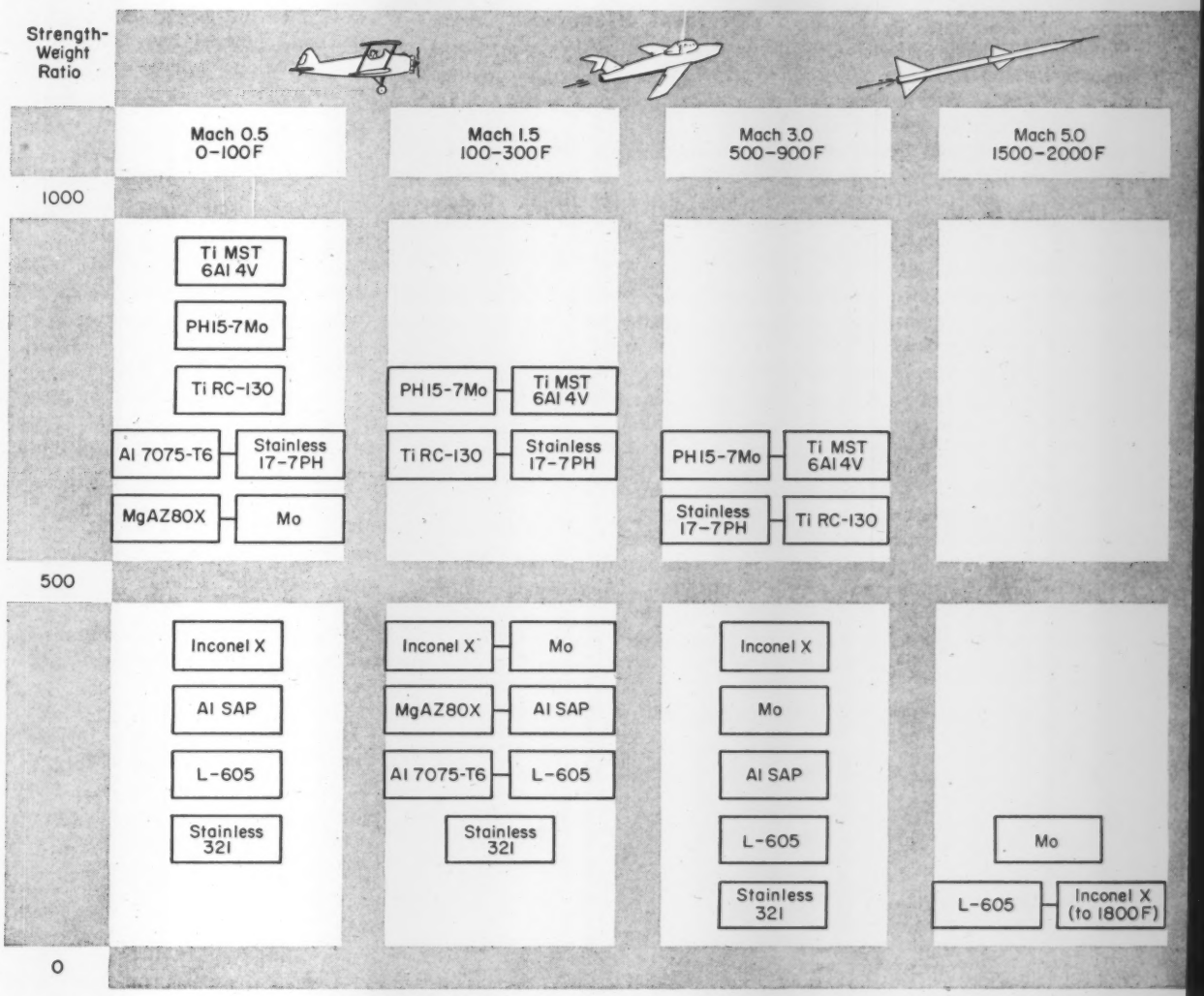
The Future of All-Metal Sandwiches



Brazed honeycomb panels will dominate the design picture for the next five years, according to SRI's prediction. Thereafter, welded panels will be more suitable for extremely high-temperature applications. Curing of present ills will make other configurations more competitive with the honeycomb. The decade from 1960 to 1970 will see adhesive bonding diminish to a field of relatively minor proportions.

SKYROCKETING use of sandwich panel in design has worried the Navy Bureau of Aeronautics. The problem: Production facilities may not keep pace with growing demand. To gage a possible shortage, BuAir commissioned Stanford Research Institute to study four facets of the problem: 1. State of the art in production and application of high-temperature, low density sandwich structures. 2. Current plans for use of sandwich structures; projection of probable design trends for the next five years. 3. Comparison between future requirements and predicted capacity for production of core material. 4. Problem areas in production and application of honeycomb-core parts and structures.

Early sandwich materials had



Temperatures associated with today's flight speeds have caused yesterday's standard fuselage materials to drop out of the picture. Materials formerly considered unusable (or too expensive) now look very attractive.

cores of wood, paper, plastic foam, and glass foam; facings were impregnated duck, impregnated paper, reinforced plastic, and aluminum. Bonding was done with adhesives. Metal sandwiches followed, with cores being formed in shapes called honeycomb, waffle, sine wave (or corrugated sheet), and egg crate. Three methods of bonding have been used—adhesive, brazing, and welding. At present, adhesive-bonded sandwich materials account for a large part of the market. But growing demands for high-temperature strength shift the emphasis to brazed sandwiches, and research is being done on welded panels.

Advantages of the Sandwich

Sandwiching materials together gives a composite structure with several design advantages:

- One panel can incorporate the properties of several materials.
- Undesirable directional properties are cancelled.
- The core moves load-bearing surfaces farther apart—fills the low-stress volume between them with a high-bulk, low-density material that saves weight and adds stiffness.

All-metal sandwich structures

were developed to meet the high operating temperatures of modern aircraft. Bonding, however, became a problem, since most available metal sandwich materials were adhesive bonded and were good to only 300-400 F. With the demands of hotter jet engines, and the skin-heating effects of faster flight, something better was needed.

Brazed panels provide a temporary solution. Production problems, however, have kept the cost of these panels high. While prices have gone steadily down with advances in the art of fabrication, an aircraft engineer recently estimated that the simple act of changing specs from integrally stiffened panel construction to brazed honeycomb panel would triple the cost. Nevertheless, the high cost may be worthwhile.

In five years, predicts Stanford Research Institute, emphasis will shift away from adhesive-bonded panels to brazed panels; SRI also foresees that in ten years temperature problems will force the almost universal use of welded panels. These may be made of more exotic materials like titanium or molybdenum.

The Shape of Sandwich Cores

Three basic core configurations, with minor variations, are being studied for sandwich panel design:

Honeycomb—found most reliable for a variety of applications. It shows high strength and rigidity in all surface directions; the sealed-cell construction can be made leakproof, and if leaks do develop they are closely contained; the surface is characteristically smooth and free of defects—an important factor in aerodynamic design.

Corrugated core — shows strong directional characteristics. Corrugations act like pipes to conduct leaking fuel or oil far from the original site of the leak. Directional characteristics may be of benefit if it is desired to form the panel after fabrication. Corrugated panel is cheaper to make, and welded panels have been successful.

Waffled panel—appearing in egg-crate, unisheet, or dimpled-core form. A single sheet is typically drawn up and down in alternating cups and mounds which are spot-welded to the facing sheets. Buttons and puckers mar the smooth surface of the panels where spot-welds are found.

Design Problem Areas

Design problems confront designers of both brazed and welded panels. These problems are pressing in the case of brazed stainless steel honeycomb-core panels, since aircraft that incorporate them are nearly ready for production. As reported to the Institute's project team, major problem areas are:

- Lack of comprehensive stress analysis and design criteria.
- Requirements for extremely tight tolerances.
- Requirements for lightweight, efficient, edge-member design.
- Need for efficient insert designs.
- Dimensional change in material during heat treatment.
- Differences in thermal expansion between connecting panels.
- Selection of correct core.

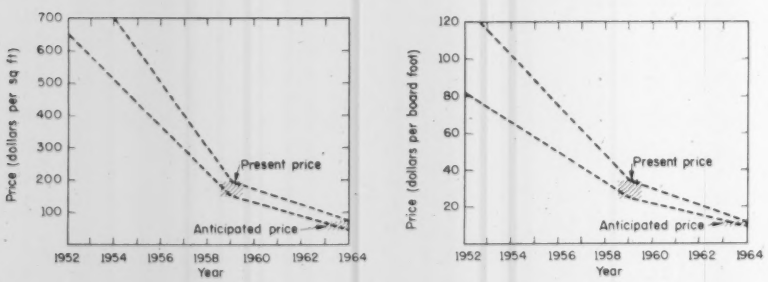
The Problem: Present Commitments—Not Future Capacity

Demand forecasts compiled by SRI indicate tremendous future usage, but there are at present few commitments in the form of firm production orders. Present business does not justify large-scale manufacturer's operations, since according to SRI, orders are for small quantities with a wide variety of shapes, sizes, and types of material. Several companies expanded their facilities to meet anticipated B-58 requirements, only to have these requirements fall far short of expectations. Even before cancellation of the F-108, fabricators were going slow on trying to anticipate demand from that and the B-70 program.

Fortunately, lead time is not critical: The simpler continuous-belt type of machine can be built in four to six weeks; blanket-type machines can be built in three or four months. Core delivery would average two to three months from the placing of an order. Longest lead time would be needed for procurement of slitted sheet stock.

Applications for All-Metal Sandwich Material

Aircraft		
Wing, fuselage, and empennage surfaces	Bulkheads	Dive brakes
	Doors	Nose and tail cones
Leading edges	Air-inlet scoops	Fire walls
Trailing edges	Ducting	Exhaust blast panels
Control surfaces	Nacelles	Sweat cooling panels
Ribs	Fuel tanks	Vibration dampeners
Jet Engine		
Compressor casings	Guide vanes	Heat exchangers
Fan blades	Engine shrouds	Mufflers
Turbine seals	Afterburner heat shrouds	Thrust reversers
Missile		
Wing surfaces	Nose sections	Bulkheads
Fins	Engine compartments	
Other		
Reactor structures	Heat exchangers	Pressurized tanks
Space vehicles	Airborne radar reflectors	Liquid-storage tanks
Hydrofoils	Acoustical insulation	Microwave reflectors
Electronic packaging	Thermal insulation	Machine housings



Improved production techniques have caused sharp reduction in the price of both brazed (left) and welded (right) honeycomb panel. Continued advance in the art of making them is expected to lower the price still further, making possible their consideration for a larger variety of applications.

These R&D Projects for Future Decades in Space

typify Lockheed's vast program of Air/Space Science

■ New programs under development at Lockheed's California Division are planned to solve America's future exploration projects into space. The new multimillion-dollar Research Center in nearby San Gabriel mountains is further evidence of Lockheed's determination to support and supplement its already extensive research and development activities.

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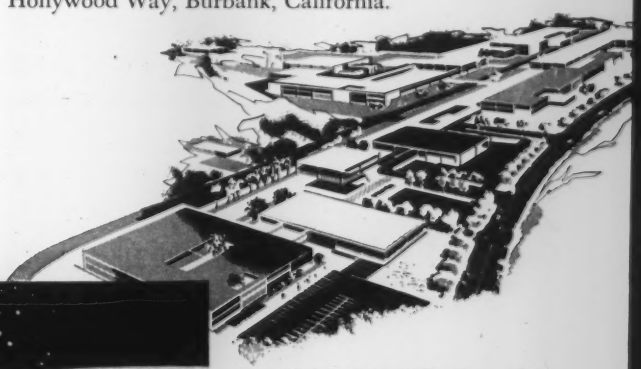
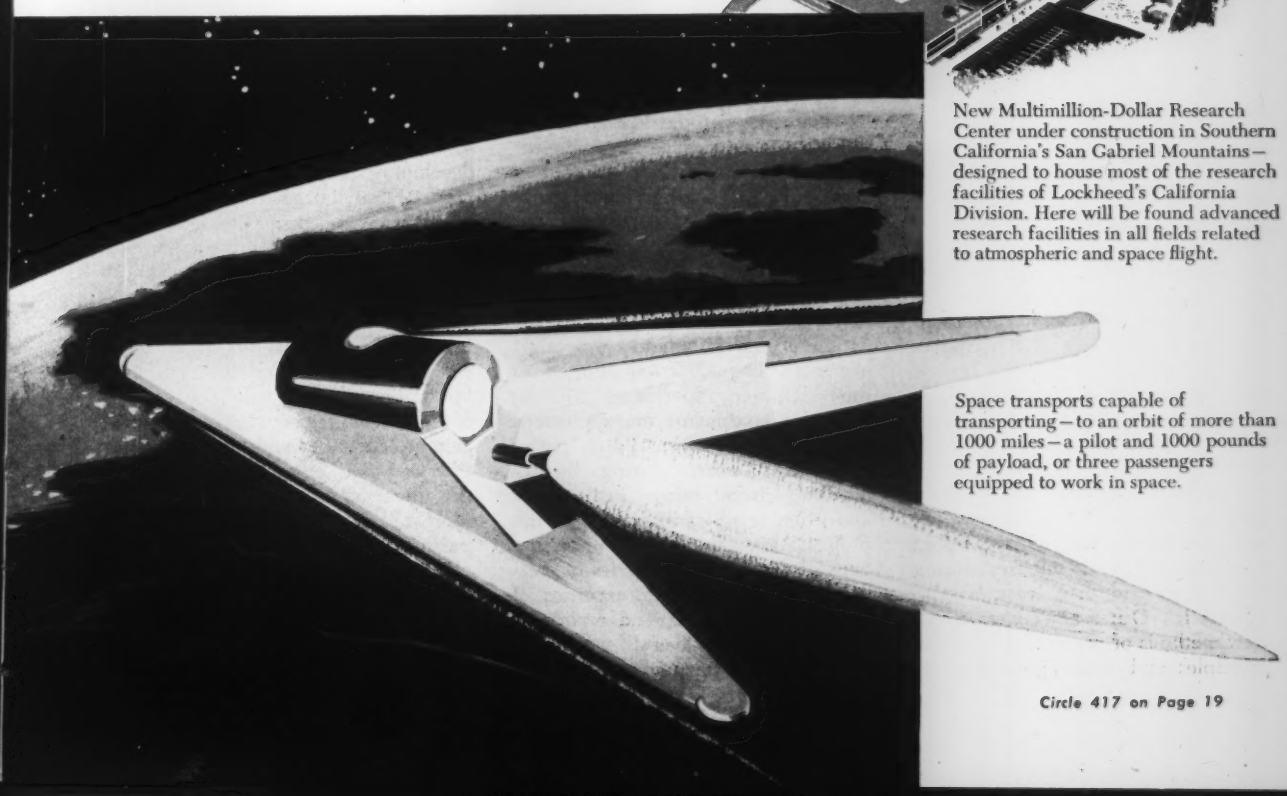


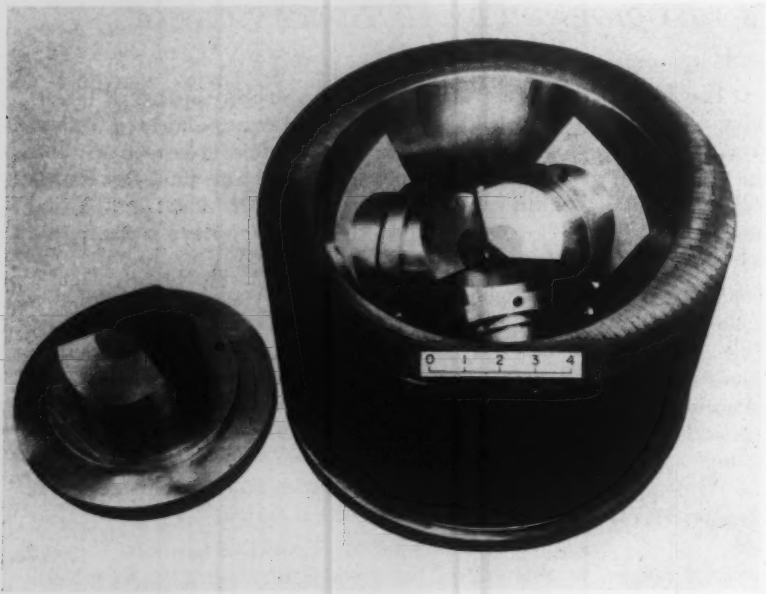
New Multimillion-Dollar Research Center under construction in Southern California's San Gabriel Mountains—designed to house most of the research facilities of Lockheed's California Division. Here will be found advanced research facilities in all fields related to atmospheric and space flight.

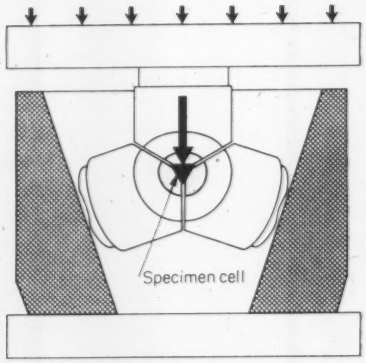


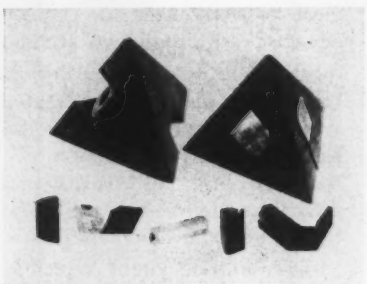
Space transports capable of transporting—to an orbit of more than 1000 miles—a pilot and 1000 pounds of payload, or three passengers equipped to work in space.

Circle 417 on Page 19

High-Pressure Problem Solver







Properties of materials at pressures as high as 100,000 atmospheres are being studied by National Bureau of Standards scientists with the aid of a unique "squeeze box." The apparatus consists of four carbide-tipped anvils that bear on the faces of a tetrahedon of pressure-transmitting material (prophyllite) in which the test specimen is imbedded, upper right. The vertical anvil is forced downward by a conventional hydraulic press, and the remaining anvils transmit reaction forces from the conical retaining ring. In a typical study—how electrical resistance changes with pressure—a specimen is inserted in a hole drilled from edge to edge in the tetrahedon (below right). Pieces of silver foil are placed in contact with each end of the specimen and bent to give an exposed face to each of the pressure anvils. Four circuits are thus available for test purposes. Teflon (0.003 in.) insulates anvils from ring.

Course in Computers Added to Curriculum at U-M

Ford Grant Permits Experiment, Provides for Recruiting Faculty

ANN ARBOR—Engineers graduating from the University of Michigan in the early 1960's should be able to use a computer with almost as much proficiency as they use their slide rules, thanks to an experimental program which will provide all engineering students enrolled during the next two years with courses in the use of computers. Such courses will probably begin in the sophomore year. Previously, engineers have received instruction in computer techniques only in special, advanced courses or in research.

It is the aim of the U-M program that all engineering graduates become acquainted with all the things a computer can do in engineering calculations and then learn how to operate it. Other objectives: to review methods of presenting scientific principles and their applications so that those principles which a computer can handle, but which may be too complex for regular teaching methods, can be introduced to students; to encourage all engineering schools to utilize computers more fully in engineering instruction.

This four-semester project is made possible through a grant of $1,175,000 from the Ford Foundation—one of the first of new Foundation grants in science and engineering. The $900,000 allotted to the computer experiment will be spent for equipment to supplement the University's IBM 704; to pay a full-time advisor, visiting faculty members from other institutions, and other teachers interested in the project; and to defray operating costs of the project—salaries of consultants and assistants, expenses of summer conferences, and reports.

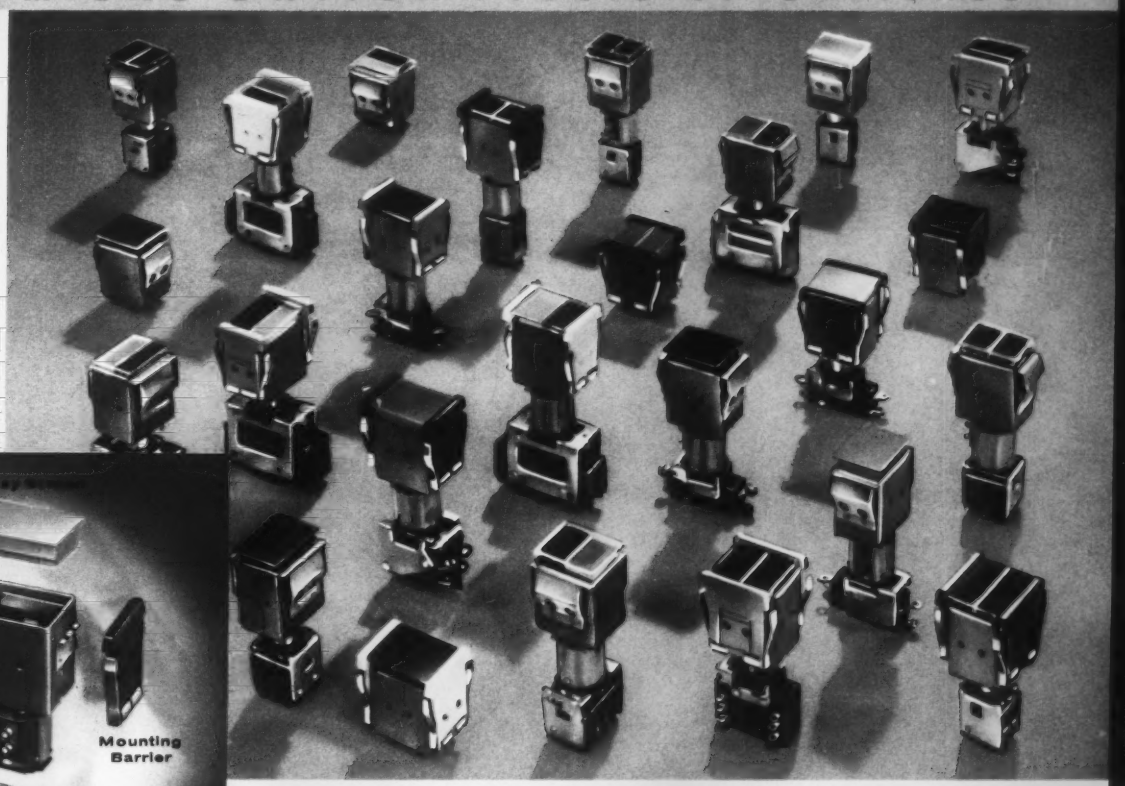
In addition, several week-long seminars have been planned to acquaint other groups with the rudiments of the use of computers in engineering education.

The other $275,000 of the Ford grant will be used for recruiting and developing promising faculty members. Financial help will be given to outstanding doctoral candidates who intend to teach engineering so that they will acquire their degrees faster.

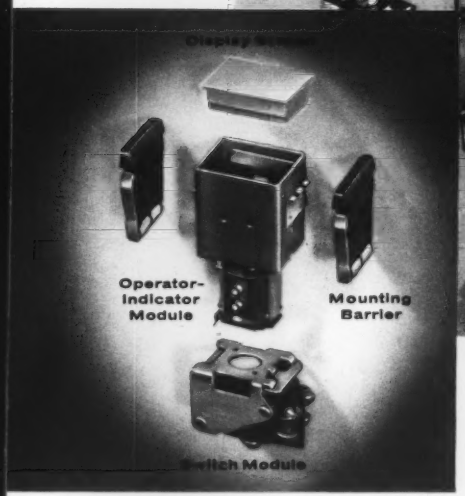
The Ford Foundation, in outlining this portion of the grant, observed that the current years are "particularly crucial to the future of engineering education. The urgent needs are to add greater scientific and mathematical emphasis to the undergraduate curricula and to increase the number of students preparing for engineering careers at all levels. Thus, the recruitment, preparation, and retention of highly qualified faculty personnel is the foremost problem of engineering education."

Circle 418 on Page 19→

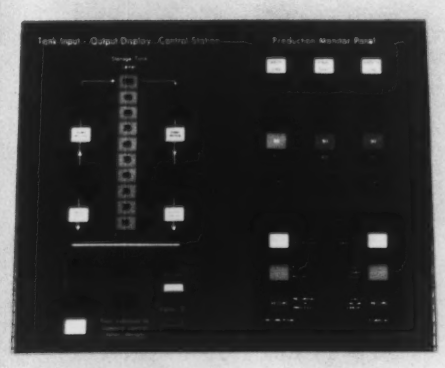
MICRO SWITCH Precision Switches



Just 25 of the hundreds of switch and indicator combinations



Modular concept allows wide choice of combinations. Parts snap together and into panels without tools.



Four Series 2 mounting types permit mounting singly or in columns or rows, provide panel design freedom.

Build your own lighted pushbutton switches and indicators with Series 2 modules

No tools are needed to put together Series 2 modular assemblies that provide a choice of hundreds of different control and display functions.

From our Catalog 67, you select modules from 48 different operator-indicator units, 12 indicators, 18 switch units, 16 mounting barriers differing in size and color, 40 color display screens, and 4 filters.

Up to 4 lamps in each Series 2 indicator module provide improved signal reliability, and choice of transmitted or projected signal color.

Catalog 67 describes Series 2 devices and switching units in detail . . . contains helpful information and application data for human factors engineers and for electrical engineers. Catalog 67 and application assistance are available on request from the MICRO SWITCH branch office near you. Or write for your copy.

MICRO SWITCH . . . FREEPORT, ILLINOIS
A division of Honeywell
In Canada: Honeywell Controls Limited, Toronto 17, Ontario

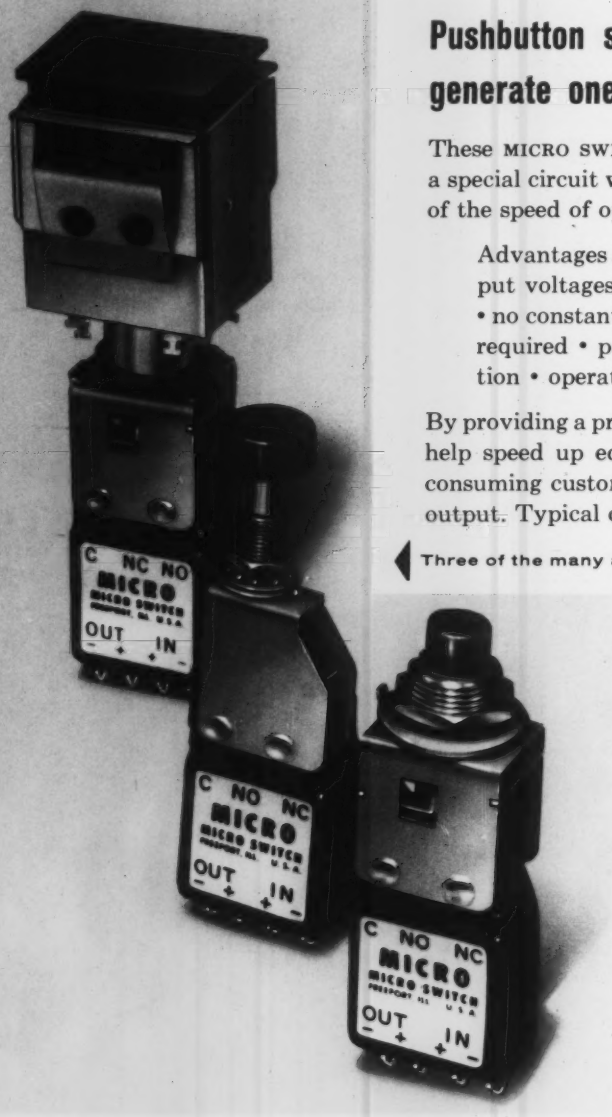
Honeywell
MICRO SWITCH Precision Switches

Pushbutton switches with built-in "One-Shot" circuit generate one square pulse per operation

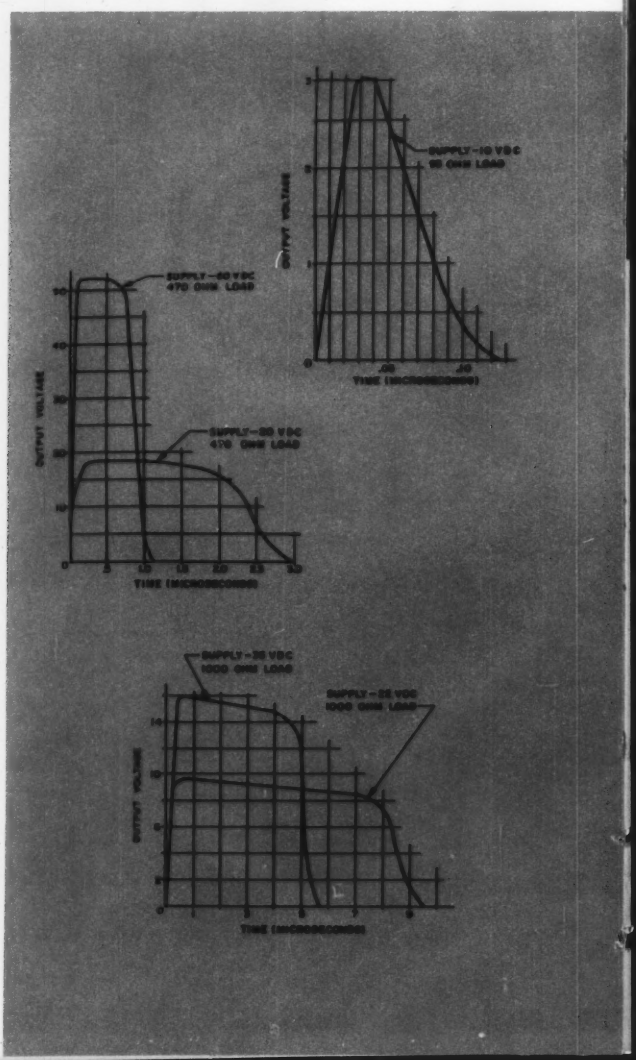
These MICRO SWITCH snap-action pushbutton assemblies incorporate a special circuit which produces a single square wave pulse, regardless of the speed of operation.

Advantages are: pulse widths from 0.1 to 10.0 microseconds • output voltages up to 180 volts • can drive loads as low as 5 ohms • no constant power drain • produce positive or negative pulse, as required • potted circuit for physical and environmental protection • operate at temperatures from —65° to +185° F.

By providing a pre-engineered, compact package, "One-Shot" switches help speed up equipment design by eliminating the need for time-consuming custom circuit development to accomplish a shaped wave output. Typical output curves are illustrated below:



Three of the many available "One-Shot" switch assemblies



The "One-Shot" switch can be supplied as an integral unit with any MICRO SWITCH pushbutton device. Applications include computer and radar consoles, keyboards, electronic test equipment, checking ring counters, setting and resetting flip-flops, and reflected pulse systems. Ask for data sheet 150.

Engineering assistance on switch application is available from the MICRO SWITCH branch office near you. Consult the Yellow Pages.

MICRO SWITCH . . . FREEPORT, ILLINOIS
A division of Honeywell
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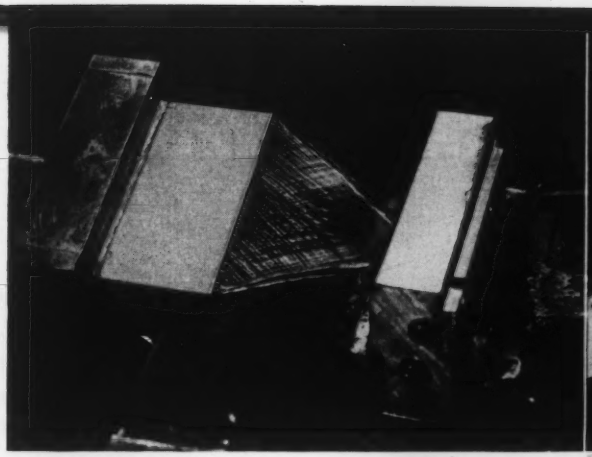
Honeywell
MICRO SWITCH Precision Switches



Electrolytic Cavity Sinker Machines the Ultrametals

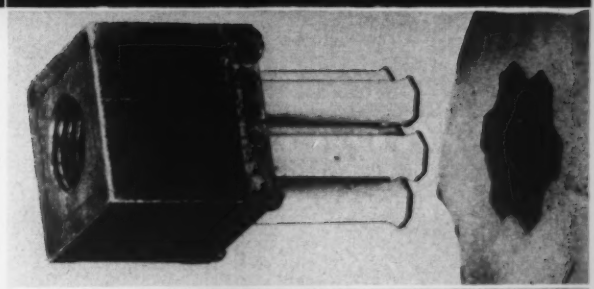
CHICAGO—Even the hardest alloys are "like butter" to a new machine tool—it penetrates at rates as high as 0.3 cu in. per min. Developed by Anocut Engineering Co., the machine is an electrolytic cavity sinker intended for production operations (as contrasted to tool-room use) on all the high-strength metals.

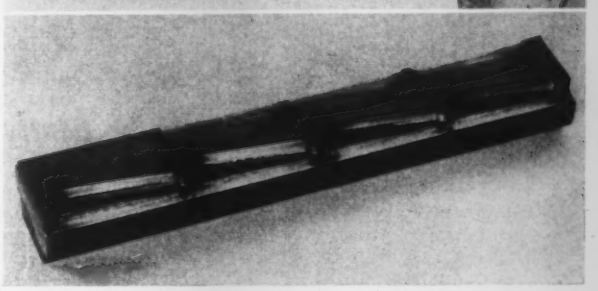
Electrolytic metal removal may be likened to an electroplating process working backwards. Material is removed from the workpiece by passing a direct current continuously through a water-base electrolyte solution between the workpiece (positive pole) and the electrode (negative pole).

Because the electrode does not rotate, irregular holes and shapes can be formed in the workpiece. The "cutting" electrode can be made in many shapes. Shape of the hole being cut depends only on the contour of the electrode advanced into the material.

The removal process does not involve high temperatures, and there is no metallurgical damage to the work from heat—the work, bathed in electrolyte, can get no hotter than the electrolyte. Removal may be concentrated in small areas with high penetration rates. And there is no electrode wear. Hundreds of identical cavities can be produced with the same electrode.

Finishes vary with the work material. On most materials it is possible to obtain a finish better than 30 to 40 mu in. On many materials, particularly the super alloys, the finish is better than 20 mu in.

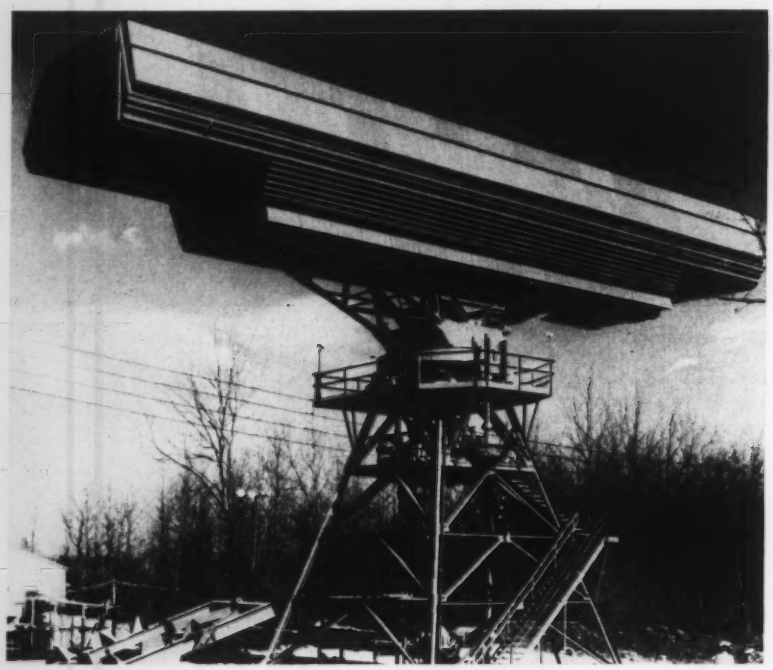




Material is eaten away from the workpiece by the action of an electric current. Electrolyte flows from the working edge of the cavity-sinking tool (negative electrode), left. The tool is normally brought up close to the work (positive electrode) before the electrolyte flow is turned on, above right. Typical operations performed on ultrahard metals are simultaneous sinking of several holes of the same or different shapes, middle right, and forming of odd shapes, lower right.

Wide new fields of use are open to the Anocut machine. Previously, electrolytic machining was restricted to applications where a rotating wheel could be used. Extensively used in industry for materials which are very hard, tough, subject to burring, or sensitive to heat damage, electrolytic machining can now be used to sink any irregular hole or shape that can be designed to follow the contour of an electrode.

←Circle 418 on Page 19

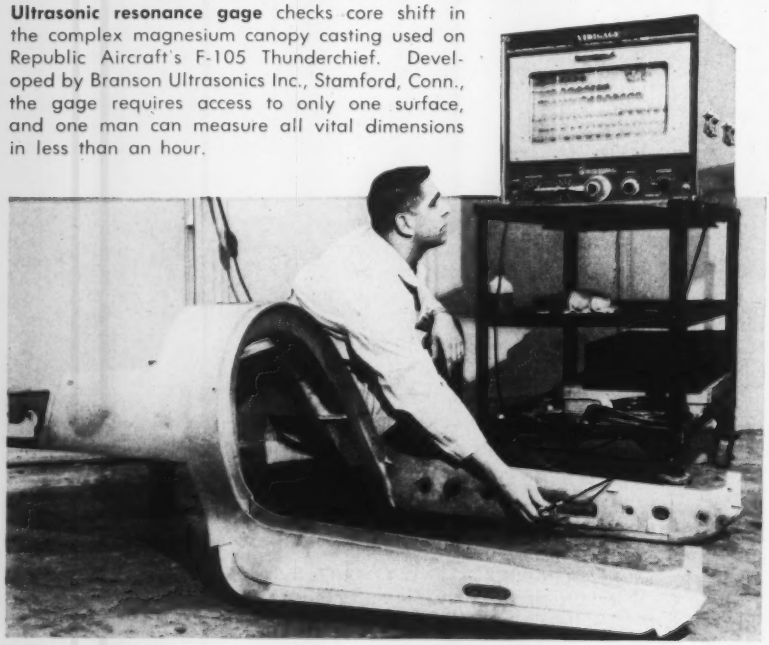


Super Sentry

Rotating "Boxcar" antenna is designed for a heavyweight radar that uses enough electrical power to light several thousand homes. Developed by Raytheon Co., Waltham, Mass., the 50-ton antenna (104 ft long) is intended for the new SAGE system that will feed advanced warning information to a central combat and computer center. It will be tower-mounted on a three-story transmitter-receiver structure. The 800-ton structure will house 262 separate units.

Close-Tolerance Wall Thickness Checked Ultrasonically

Ultrasonic resonance gage checks core shift in the complex magnesium canopy casting used on Republic Aircraft's F-105 Thunderchief. Developed by Branson Ultrasonics Inc., Stamford, Conn., the gage requires access to only one surface, and one man can measure all vital dimensions in less than an hour.



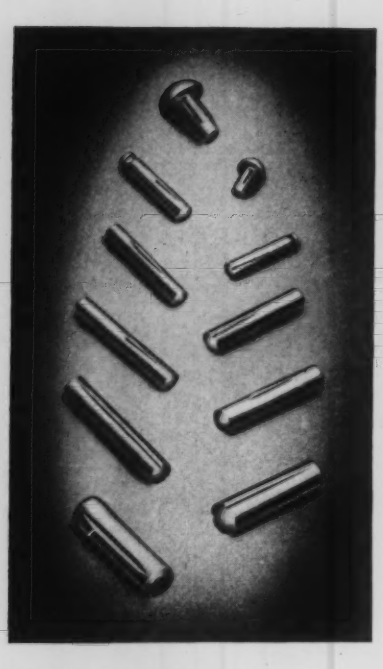
Special Machinery Builders: Why spend engineering time and money detailing clutches, bearings, drive sheaves, and control equipment when you can buy them in a package? Especially when that package gives you faster cycling, more automatic control, easier pushbutton jogging, and greater versatility! Yes, all the benefits of Warner electric motion control—now practical in every way for one-of-a-kind applications. It's a pre-engineered, completely assembled clutch-pulley combination—Warner's new Electro-Sheave. Just slip it over any standard NEMA motor shaft, tighten the setscrew, mount the brush-holder, and belt the sheave to the machine. Any switch actuates the clutch. The simple wiring from the brushholder to the control panel speeds assembly, eliminates machined parts, reduces maintenance.

Five sizes (1 to 25 hp) available for quick delivery from any Warner distributor. Write for complete information and easy selection tables in Bulletin P-52.

WARNER

Warner Electric Brake & Clutch Co.
Beloit, Wisconsin

Circle 420 on Page 19

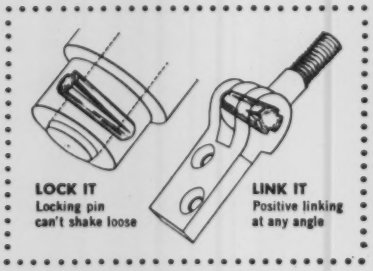


To join two parts as one...

THE SOLID GROOV-PIN

Every one of the Groov-Pins shown here was designed with your pin problems in mind. Designed to withstand the rigors of constant shock and vibration without loosening...to drive easily into a simple drilled hole...for faster hand or production feeding, including hopper feed...for a permanent connection that stands up to vibration fatigue as only a solid pin can.

Groov-Pins are made to meet your requirements, too. Standard sizes run from 1/32 to 1/2", specials to fit your needs at standard prices over 5,000 pieces. Send for illustrated catalog, free samples.



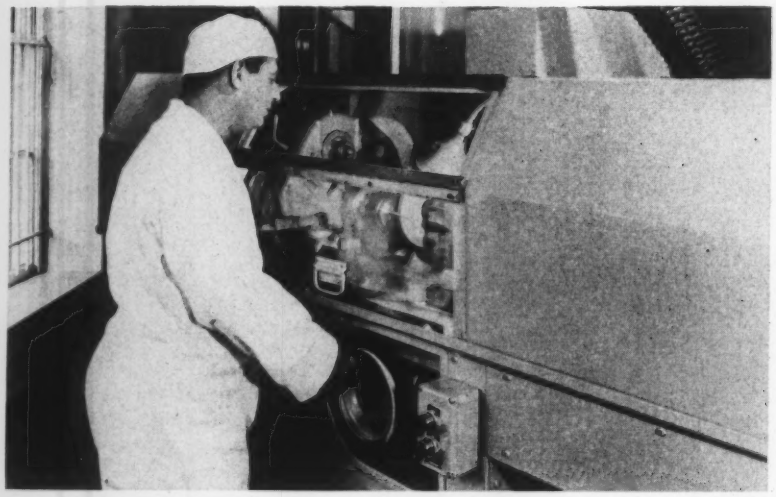
No matter what your pin problem, there's a Groov-Pin to solve it for you.

GROOV-PIN
CORPORATION
1130 Hendricks Causeway
Ridgefield, New Jersey WHitney 5-6780

Circle 421 on Page 19

Small, Powerful Computer Suited to Engineering Work

Transistorized stored-program computer, comparable in size to a desk or drafting table, can perform more than 100,000 calculations a minute. It consists of a central processing unit and a paper tape reader and punch; a modified electric typewriter is also used for input and output. Ordinary decimal arithmetic facilitates communication between machine and operator. Possessing a capacious (20,000 digits of magnetic core storage) but "economical" memory, the IBM 1620 scientific computer was designed for complex technical tasks. One programming technique is the FORTRAN (formula translation) system, set up especially for engineering and research calculations. Programs, written in the form of equations, are compiled automatically.



Beryllium Bolts

Nearest thing to antigravity structural material will be fabricated in a new facility of Standard Pressed Steel Co., Jenkintown, Pa. The exotic-metals laboratory is the first to fabricate featherweight beryllium—one-fourth the weight of steel and more costly than gold—into threaded fasteners. Missile and satellite fasteners (and further research on fastener design and metal-processing techniques) will come from this new pilot plant operation, say spokesmen. A leader in the field of high-strength fasteners, SPS expects to lick problems with beryllium as it has with titanium and high-strength steels in the past.

Four Russian Journals Translated By ISA

PITTSBURGH—The Instrument Society of America will continue its program of translating and publishing English editions of four leading Russian technical journals. Funds have been made available by a National Science Foundation grant.

The four publications translated are: *Measurement Techniques* (Izmeritelnaia Tekhnika), *Instruments and Experimental Techniques* (Pribory i Tekhnika Eksperimenta), *Automation and Remote Control* (Avtomatika i Telemekhanika), and *Industrial Laboratory* (Zavodskaya Laboratoriya). Both 1958 and 1959 issues are available at low subscription rates.

Measurement Techniques is a monthly (about 100 pp.) concerned with the study and application of fundamental measurement. *Instruments and Experimental Techniques* is a bimonthly (175 pp.) dealing with function, construction, application, and operation of instruments. *Automation and Remote Control* is a monthly (150 pp.) considered the leading Soviet journal in the automatic control field. *Industrial Laboratory* is a monthly (125 pp.) concerned with instrumentation for analytical chemistry and physical and mechanical methods of material research and testing.

Serving U. S. science and industry, the program is in its third year of providing information on latest Soviet instrumentation.

Meetings and Shows

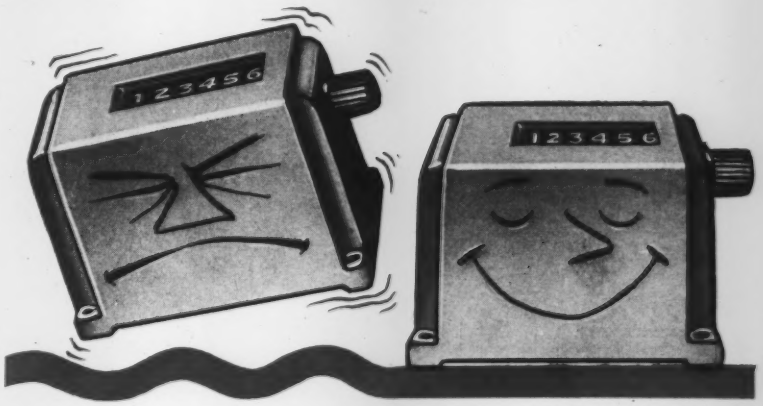
Nov. 23-25—

American Management Association. Conference on "Capitalizing on Technology" to be held at the Ambassador Hotel, Los Angeles. Further information is available from AMA headquarters, 1515 Broadway, New York 36, N. Y.

Nov. 30-Dec. 3—

Eastern Joint Computer Conference to be held at the Statler Hotel,

RECTIFICATION MAKES THE DIFFERENCE



• More than doubles count life
• Provides reliable operation from 25/40/50/60 cycles
• Broadens range of permissible line voltage variation

— these great improvements, achieved through built-in rectification of AC models —

Make possible the unmatched count life ratings of CE-800 and PIC-600 counters shown below.

Assure CE-800 and PIC-600 performance from AC Service not even approached by non-rectified counters

In addition to the above PIC manufactures Endurance Rated counters for every purpose, including

- Stroke and Revolution Counters
- Automatic Batch Counters
- A complete line of Actuating Switches for Electric Counters.

Whatever your needs see your PIC Representative or Distributor or write for literature.

CE-800 Electric Counter
200 million count life
from 25/40/50/60 cycles and DC

Sensitive Actuating Switch
100 million count life
one of several developed especially for counter actuation.

PIC-600 Electric Counter
50 million count life
from 25/40/50/60 cycles and DC

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Circle 422 on Page 19

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If a ball of any conceivable size, material, or modification can help you, you'll want this free bulletin, "BALLS UNLIMITED." It contains 8 pages of helpful information, featuring . . .

- **STOCK BALLS** *of ceramic, Hastelloy® B and C, M-10 steel, nylon, synthetic sapphire, Teflon®, tungsten carbide — their complete specs — properties of each material — and recommended uses.*
- **SPECIAL BALLS** *of all workable materials — all sizes, standard and special.*
- **MODIFIED BALLS** *with tapped, counterbored, or chamfered holes, flats, grooves, stems.*

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Boston. Sponsors are IRE and AIEE. Further information can be obtained from Margaret Fox, Secretary-treasurer, EJCC, P. O. Box 4999, Washington 8, D. C.

Nov. 30-Dec. 4—

American Society of Mechanical Engineers. Annual Meeting to be held at Chalfonte Haddon Hall, Atlantic City, N. J. Further information is available from Meetings Dept., ASME, 29 W. 39th St., New York 18, N. Y.

Nov. 30-Dec.4—

Exposition of the Chemical Industries to be held at the Coliseum, New York. Further information can be obtained from exposition headquarters, 480 Lexington Ave., New York 17, N. Y.

Dec. 7-11—

National Conference on the Application of Electrical Insulation to be held at the Sheraton-Park Hotel, Washington, D. C. Sponsors are American Institute of Electrical Engineers and National Electrical Manufacturers Association. Additional information can be obtained from AIEE headquarters, 33 W. 39th St., New York 18, N. Y.

Dec. 8-9—

First Aerospace Finishing Symposium to be held at the Hotel Texas, Fort Worth. Sponsors are the Society of Aircraft Materials and

"Maybe if we put metal in, we'd get that metallic look."

Process Engineers and the Dallas-Fort Worth branch of the American Electroplaters Society. Further information is available from the Southwest Society of Aircraft Material & Process Engineers, 1026 South Adams, Fort Worth, Texas.

Dec. 15—

Material Handling Institute Inc. Annual Meeting to be held at the Savoy-Hilton Hotel, New York. Further information is available from Hanson & Shea Inc., 1 Gateway Center, Pittsburgh 22, Pa.

Dec. 17—

Institute of the Aeronautical Sciences. Wright Brothers Lecture to be held at the Natural History Bldg. Auditorium, Smithsonian Institution, Washington, D. C. Further information is available from IAS headquarters, 2 E. 64th St., New York 21, N. Y.

Jan. 11-13—

Sixth National Symposium on Reliability and Quality Control in Electronics to be held at the Statler-Hilton Hotel, Washington, D. C. Sponsors are Institute of Radio Engineers, American Society for Quality Control, Electronic Industries Association, and American Institute of Electrical Engineers. Additional information can be obtained from IRE headquarters, 1 E. 79th St., New York 21, N. Y.

Jan. 15—

Malleable Founders Society. Semi-annual Meeting to be held at the Hotel Sheraton-Cleveland, Cleveland. Further information is available from society headquarters, 781 Union Commerce Bldg., Cleveland 14, Ohio.

Jan. 25-28—

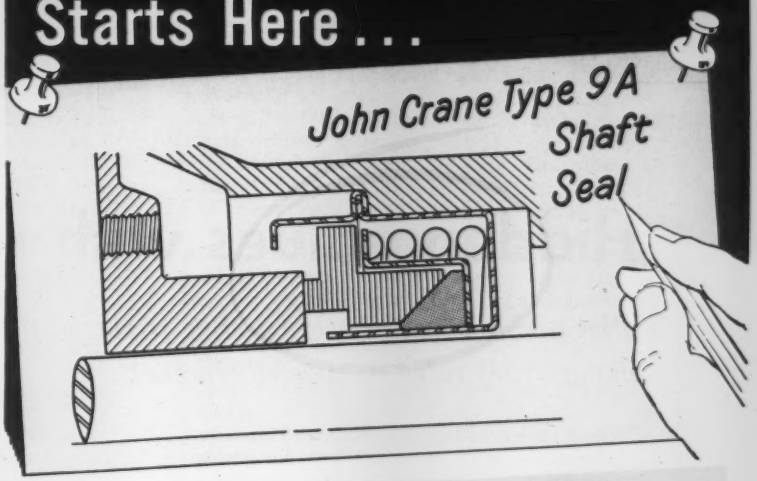
Institute of the Aeronautical Sciences. Annual Meeting to be held at Hotel Astor, New York. Further information is available from IAS headquarters, 2 E. 64th St., New York 21, N. Y.

Jan. 25-28—

Plant Maintenance and Engineering Conference to be held at Convention Hall, Philadelphia. (Conference dates are Jan. 25-27.)

(Please turn to Page 48)

Sealing Corrosive Liquids Starts Here...

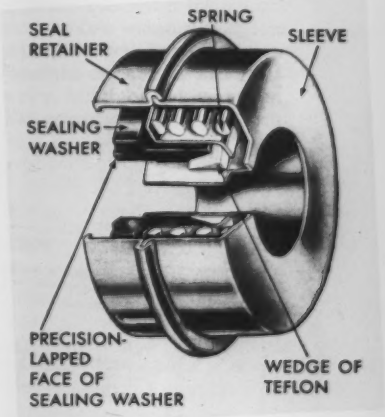


This cartridge-type shaft seal designed for the production line is engineered for:

(1) positive sealing of many industrial chemicals and solvents (note the Teflon* sealing wedge);

(2) leakproof handling of inflammables and toxics;

(3) operation over a wide temperature range from −120° to +500°F., pressures to 150 psi.



It offers the Original Equipment Manufacturers these important advantages:

(1) low unit cost through mass production;

(2) fast, one-piece installation through cartridge construction;

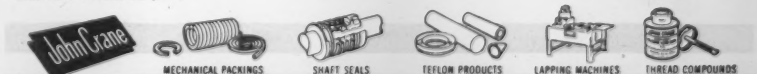
(3) equal efficiency on both low or high speed applications, because seal does not rotate with shaft.

The 9A Shaft Seal can be of stainless steel, monel, brass or other materials adapted to stamping and forming—depending on the service requirement.

Get full details. Request Bulletin S-205-3 from Crane Packing Co., 6425 Oakton Street, Morton Grove, Illinois *(Chicago Suburb).*

In Canada: Crane Packing Co., Ltd., Hamilton, Ont.

**DuPont Trademark*



CRANE PACKING COMPANY

OFFICES IN ALL PRINCIPAL CITIES

Circle 424 on Page 19

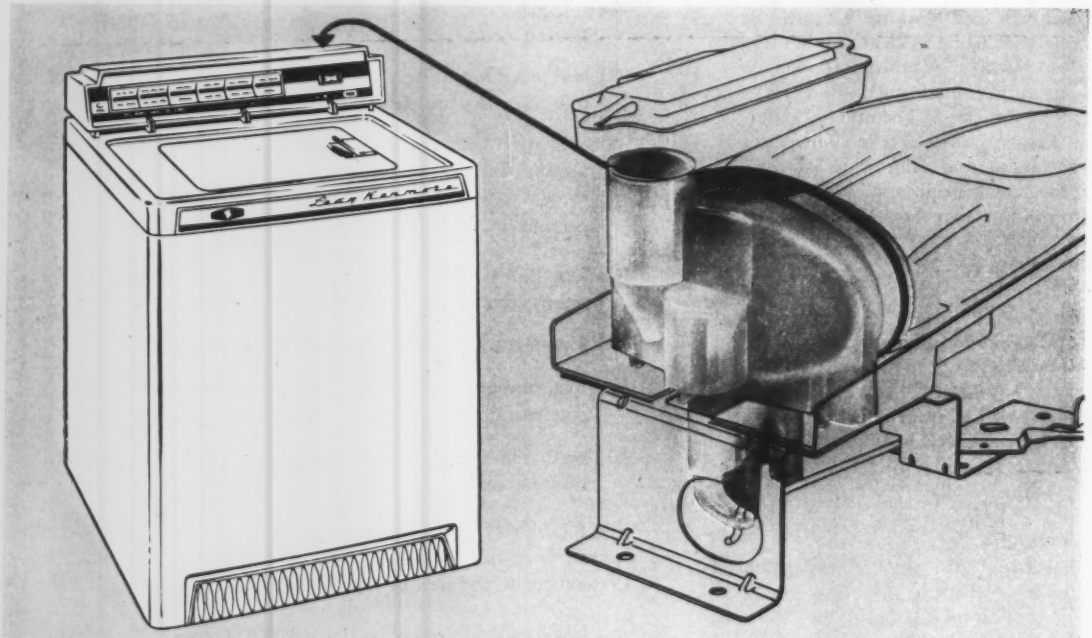
HERCULES

Plastics Hi-lites

Hidden values with new plastics

The inside story of seldom-seen parts performing demanding roles in new equipment

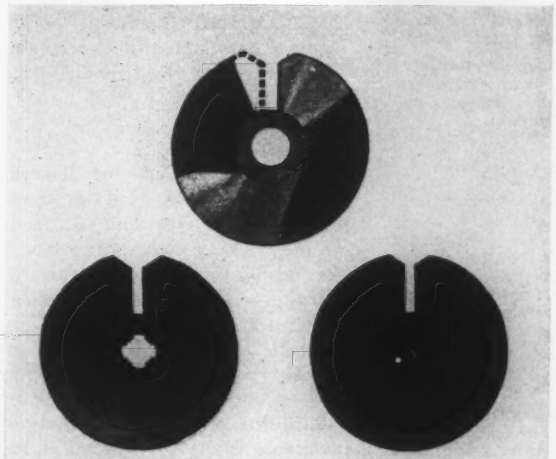
Today's consumer is prone to take advanced engineering features of new products for granted. Industrial users, too, have come to expect superior performance and greater serviceability from every piece of new equipment. Here are a few of the ways that design engineers are using Hercules new plastics to build added values into their products without increased cost. Able to work for the first time with thermo-plastics which are truly structural materials, they have found it possible to make one part do the work of many. Rapid-cycle injection molding produces the new precision-formed units at low cost, and the properties of the new materials provide the stamina and durability which assure faithful, trouble-free service.



Handsome styling, luxurious appointments, and its many extra service features have made the Lady Kenmore Clothes Washer one of the nation's best sellers. But it's the engineering and quality of construction inside the Lady Kenmore which enables Sears to maintain its reputation for *big value* merchandise. A significant example is the advanced design of the rinse dispenser developed by The Dole Valve Company, Morton Grove, Illinois, especially for this outstanding machine. The heart of the unit (shown in position in the diagram with the rest of the assembly in outline) is precision molded with Pro-fax®, Hercules' polypropylene. Pro-fax, the newest and most versatile of thermoplastic, provides a part that is immune to rust and the corrosive attack of detergents, highly resistant to heat, mechanically strong, and functionally sound.

How a one-piece Penton® Part replaced five individual parts

When Economics Laboratory, Inc. developed its new Drymaster*—a proportionate pumping system to automatically dispense its nationally known line of chemical formulations for commercial dishwashing—it faced the problem of finding a material to replace its conventional 5-piece bronze disc and carbon half-ball assembly. Failures in the Drymaster after only a few months of service were directly traced to wear of the disc and half-ball, and Economics Laboratory thoroughly evaluated more than 150 materials before selecting Penton®. The success of Penton in the



Here's dramatic evidence of Penton's superior wear characteristics after 100,000 gallons of 220°F. hot-water service. Slot in bronze disc (at top) has worn away to an extent that the meter no longer functions accurately Penton test disc (at left) remains relatively unchanged after same exposure, as compared with production line part (right photo).

Drymaster is typical of the way this versatile new thermoplastic can be precision-molded to provide superior, low-cost replacements for expensive machined metal parts.

Although one of the newest of plastics, Penton chlorinated polyether was exhaustively tested during five years of product evaluation prior to its recent introduction as a commercial material for use in such applications as: valves, pipe, fittings, tank linings, pump and meter parts.

For complete details on Penton, including a folder charting Penton's resistance at elevated temperatures to more than 250 chemicals, call or write Hercules.

**Tradename of Economics Laboratory, Inc., St. Paul, Minn. Information regarding meters and Disc and Half-Ball Assemblies is available from the Industrial Division, Economics Laboratory, Inc., St. Paul 1, Minnesota.*

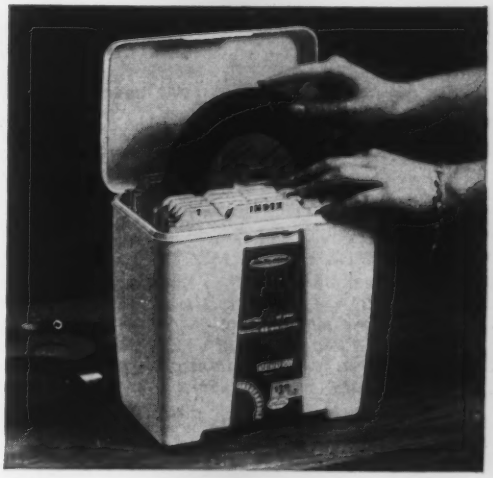
Design Hi-lites

The idea of forming a complete plastic container having a molded hinge and catch to join the body and the lid is not new. However, prior to the advent of Pro-fax® polypropylene, it was not possible to achieve a tough, rigid unit of this type, with a hinge of virtually unlimited flex life and a tight-fitting, easily operable fastener.

The economic advantages of such an assembly—whether it is designed to serve as an appliance housing, in luggage, or for consumer packaging—are readily apparent. Fittings can be eliminated, together with the costs of finishing and assembly. In many instances, the completed part emerges from the mold, ready for shipment and use.

Whether you expect to use Pro-fax to exploit this special design feature, or because of its many other desirable properties, we'll be glad to help you with your product planning. Our technical service group has had extensive experience in designing, engineering, and processing Pro-fax for products of all types. It can assist you in the development of parts which will take optimum advantage of the properties of this versatile plastic, and, at the same time, minimize processing, finishing, and assembly problems.

A fine example of a handsomely styled new product which "hinges" on Pro-fax is the "Platter Porter", a new phonograph accessory which promises to become a teen-ager's "must". Designed and produced by Columbus Plastic Products, Columbus, Ohio, this portable case for 45rpm records is lightweight, colorful, with a striking leather-grain finish impervious to weathering, staining and hard knocks. With a molded hinge and catch, there's no risk of breakage at these key points, and at the same time this new approach to luggage design greatly simplifies assembly and finishing problems.



CP59-20

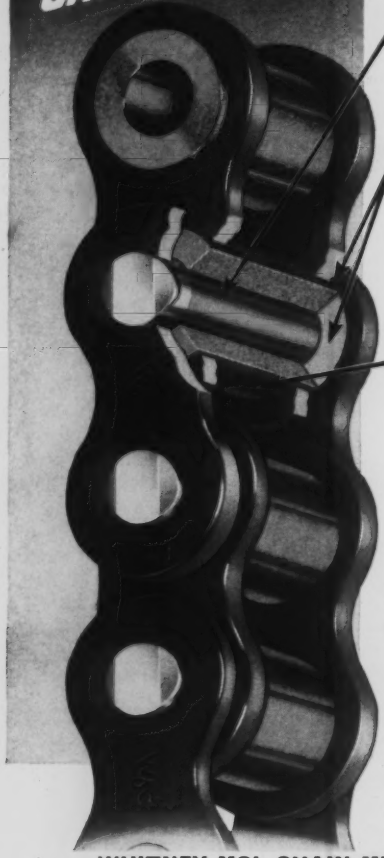
HERCULES POWDER COMPANY
INCORPORATED
900 Market Street, Wilmington 99, Delaware

THREE NEW MATERIALS FOR THE PLASTIC INDUSTRY

HI-FAX® HIGH-DENSITY POLYETHYLENE • PRO-FAX® POLYPROPYLENE • PENTON® CHLORINATED POLYETHER

HERCULES

Only Whitney MSL* Chain Provides Complete BUILT-IN LUBRICATION At All 3 Critical Areas



Whitney MSL Chain is lubricated for life by oil-impregnated, sintered steel bushings —an exclusive development of Whitney Research. With this development, Whitney solves a basic chain problem . . . **more damage is caused by faulty chain lubrication than by years of normal service.** Pressure and heat cause built-in lubricant to expand and flow from bushings, providing a constant supply of lubricant to every working part of the chain. When drive stops, bushings re-absorb oil, ensuring a permanent oil supply for the life of the chain. By solving the lubrication problem, and because of other important design advantages, Whitney MSL Chain outlasts conventional chain as much as 5 to 1 in severe operating environments.

Critical Area 1

PIN—Protective film of oil completely lubricates the live bearing area between pin and bushing, minimizing wear by reducing metal-to-metal contact.

Critical Area 2

PLATES—Whitney oil-impregnated sintered steel bushings extend beyond surface of inside plates to: act as lubricated thrust bearings, control clearance, and provide an oil cushion between plates, eliminating plate galling and seizing frequently caused by misalignment of sprockets.

Critical Area 3

SPROCKET ENGAGEMENT — Oil film on exterior surface of Whitney MSL Sintered Steel Bushings provides constant lubrication between sprocket teeth and chain. Whitney MSL Chain requires no rollers, as the tough oil film on the bushing surface provides smooth sprocket engagement, cushions impact and reduces drive wear.

Whitney oil-impregnated bushings—developed through continuous Whitney Research—are produced exclusively by Whitney to assure MSL Chain users of highest quality and reliability.

Inherent material characteristics of Whitney Sintered Steel Bushings, plus bushing configuration that provides greater contact area between bushings and links, permit high interference fit, which pre-loads links and gives maximum fatigue resistance.

Controlled clearance between plates promotes self-cleaning action.

WHITNEY MSL CHAIN MEETS ASA STANDARDS

All essential dimensions of Whitney Standard and Extended Pitch MSL Chain conform fully to ASA Standards, making it completely interchangeable with any similiar pitch ASA standard chain, simplifying specification for new equipment, or as a replacement for existing drives.

Whitney MSL Chain is carried in stock by Distributors in all parts of the United States, for prompt delivery.

***Maximum Service Life**

Whitney *Advanced Design is a Whitney Tradition*
CHAIN COMPANY

A Subsidiary of Foote Bros. Gear and Machine Corporation
4567 S. Western Boulevard • Chicago 9, Illinois

(*Continued from Page 45*)

Further information can be obtained from Clapp & Poliak Inc., 341 Madison Ave., New York 17, N. Y.

Jan. 26-27—

Society of Vacuum Coaters. Third Annual Meeting to be held at the Hotel Biltmore, New York. Technical sessions will be on Wednesday. Further information is available from John H. Smith, Application Engineer, Technical Services Dept., Consolidated Electrodynamics Corp., 1775 Mt. Read Blvd., Rochester 3, N. Y.

Feb. 1-4—

American Society of Heating, Refrigerating and Air-Conditioning Engineers Inc. Semiannual Meeting to be held concurrent with the Second Southwest Heating and Air-Conditioning Exposition, which is under the auspices of ASHRAE, in Dallas. Headquarters for the society meeting will be the Baker Hotel; the exposition will be in Memorial Auditorium. Further information is available from ASHRAE, 234 Fifth Ave., New York 1, N. Y.

Feb. 1-5—

Instrument Society of America. Instrument-Automation Conference and Exhibit to be held at the Coliseum, Houston, Tex. Further information can be obtained from ISA headquarters, 313 Sixth Ave., Pittsburgh 22, Pa.

Feb. 2-4—

Society of the Plastics Industry Inc. Fifteenth Reinforced Plastics Div. Conference to be held at the Edgewater Beach Hotel, Chicago. Further information is available from SPI headquarters, 250 Park Ave., New York 17, N. Y.

Feb. 3-4—

Midwest Welding Conference to be held at Illinois Institute of Technology, Chicago. Sponsors are Armour Research Foundation and the Chicago section of the American Welding Society. Additional information can be obtained from Harry Schwartzbart, Supervisor of Welding Research, Armour Research Foundation, 10 W. 35th St., Chicago 16, Ill.

The Bruning man introduces the most wanted whiteprinter ever!

BRUNING *Copyflex®*

Bruning's new Copyflex Model 440 gives you everything you've most wanted in a reproduction machine—at the lowest price ever!

You get a spacious 42″ printing width, powerful 4,000 watt lamp, and a mechanical speed of 40 f.p.m. . . . plus such conveniences as automatic separation, a foot lever for releasing incorrectly fed stock, adjustable front print tray, automatic tracing stacker, new air filtering system that assures cleaner prints, and a pressure-roller developer system that provides positive print development at all speeds. The 440 is equipped for roll stock, provides selective front or rear print delivery. Like all Bruning built Copyflex machines, it's odor-free, durable, and dependable. You have everything to gain by mailing the coupon.

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☐ Please send me information on your new low-cost Model 440.

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Address_____

City_____ County_____ State_____

The Bruning man is your expert on diazo reproduction. He's backed by a company with over sixty years' experience.

Circle 427 on Page 19

Fewer replacements, farther between

...with these LINK-BELT conveyor and elevator chains

LINK-BELT C CLASS CHAIN combines cast malleable center links with steel sidebars connected by steel pins. Broad tops and bottoms provide ample sliding surfaces for drag conveyors. Also available with Promal or "file-hard" Promal center links for extreme loads and abrasive wear. Promal is the special Link-Belt metal that lasts much longer . . . costs but little more.

LINK-BELT SS CLASS BUSHED CHAIN. If your conveyor or elevator must be lengthened, or load increase accommodated, you can install this all-steel chain in place of C Class *without changing sprockets!* It offers hardened joint bearing surfaces for greater wear resistance in heavy-duty conveying and elevating. Smooth, tough joint surfaces repel gritty materials, prevent packing, and resist abrasion.

Full information on these chains . . . plus a broad line of attachments — is contained in Catalog 1050. Get your copy by writing direct . . . or call your nearest Link-Belt office, listed under CHAINS in the yellow pages of your local Phone Directory.

LINK-BELT

CHAINS AND SPROCKETS

LINK-BELT COMPANY: Executive Offices, Prudential Plaza, Chicago 1. To Serve Industry There Are Link-Belt Plants, Sales Offices and Stock Carrying Distributors in All Principal Cities. Export Office, New York 7; Australia, Marrickville (Sydney); Brazil, Sao Paulo; Canada, Scarboro (Toronto 13); South Africa, Springs.
Representatives Throughout the World. 15,066

Circle 428 on Page 19

Why Chrysler chose Purolator filtration for its new Valiant...

Purolator supplies both the air filter and oil filter for Chrysler's dramatic new Valiant. One important reason: Chrysler has proved that Purolator gives superior performance. • Compactness is another important reason. The Micronic® oil filter, for example, is more compact because Purolator puts lots of effective filter area into a small volume. It suits the Valiant to a T—permits more efficient use of the smaller space under the hood. • There are many other reasons why Chrysler chose Purolator filters, of course, and why it may profit you to investigate Purolator filtration. Just write and ask.

Filtration For Every Known Fluid

PUROLATOR
PRODUCTS, INC.
RAHWAY, NEW JERSEY AND TORONTO, ONTARIO, CANADA

Circle 429 on Page 19

Memo on Metals

New Age-hardenable Titanium Alloys Offer Up to 220,000 psi Tensile Strength and Easier Formability for 600 to 1,000 F Applications

Three new age-hardenable titanium alloys may prove to be the solution to many of the strength-weight and temperature problems encountered in designing advanced aircraft and missiles. They may also prove extremely economical for such applications.

All three offer much higher strengths than other titanium alloys – and have the light weight and corrosion resistance typical of titanium alloys. Furthermore, they are readily FORMAGEABLE* – capable of being formed in the solution-treated or "soft" condition and then strengthened by simple thermal aging techniques. Each is now in pilot production and available in limited quantities of mill products.

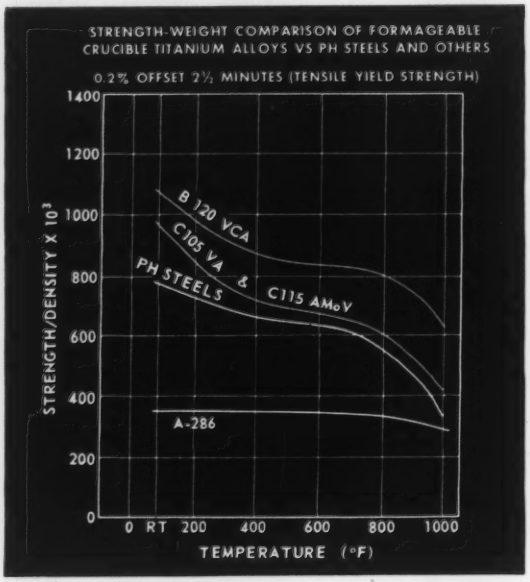
First Age-hardenable All-beta Ti Alloy

Crucible B-120VCA is the first useful titanium alloy with an all-beta (high temperature) structure. It has both the highest strength and best formability of any titanium-base alloy.

This alloy's composition (13%V-11%Cr-3%Al) enables its structure to stay all-beta during forming and/or during slow cooling, and to age to high strength levels at temperatures where distortion is not a problem.

B-120VCA has a unique combination of properties. Room temperature strengths of 200,000 to 250,000 psi have been obtained. On a strength-weight basis this is the highest strength of any available structural material. In short-time elevated temperature tensile tests (1-2 minutes), it offers a decided strength-weight advantage over alternate materials at temperatures up to at least 1,000 F. Under creep conditions, for very long periods of time, it enjoys a strength-weight advantage up to at least 600 F. Beyond this limit, the other Crucible FORMAGEABLE titanium alloys are recommended.

B-120VCA is ductile-weldable, cold-headable, and has great and deep hardenability. Because of this formability, it should prove suitable for applications such as aircraft skins, stiffeners and other primary structural shapes, and for missile pressure tanks, rocket motor cases and structural members. Preliminary tests indicate it may prove unequalled as a construction material for honeycomb assemblies. Because



it is so easy to cold-head, it has a large potential in such items as rivets.

Alpha-beta Titanium-base Alloys

Crucible C-105VA is an alph-beta titanium-base material which also is FORMAGEABLE. Its 16% vanadium content stabilizes a sufficient amount of the beta phase for good age-hardenable response; the 2.5% Al content improves the alloy's elevated temperature properties.

C-105VA resolves two conflicting requirements for aircraft sheet material. It is soft, ductile and easily formed in the solution-quenched condition. Because the formed parts can be aged subsequently at moderate temperatures, parts made of C-105VA can possess high strengths at temperatures up to 800 F for long periods of time.

* *age-hardenable titanium alloys*
* *tool steels in production parts*
* *borated stainless steels*

This third alloy, C-115 AMoV (4%Al-3%Mo-1%V), also shows considerable promise for aircraft sheet applications. It is age-hardenable to higher strengths than C-105VA with only slight sacrifice in forming characteristics.

Considerable data on the properties and fabricating qualities of all three alloys have been assembled by Crucible's Titanium Division. For data sheets and additional information, send the coupon.

Tool Steels Replace Standard Alloys for Production Parts

As design and metallurgical engineers require materials with improved properties or greater uniformity, they are turning more to the use of tool steel for production parts. Here are three good examples:

1. Vanes in the hydraulic system that actuates the automatic steering mechanism on cars **are made of Crucible REX® M-2 high speed steel. REX M-2 combines the abrasion resistance necessary for minimum wear with the impact resistance needed for long life and safety. The manufacturer experimented with numerous other steels, but high speed steel lasted longer than any other type tested.**

2. Actuator bars for a nationally-known calculator are now being produced of Crucible KETOS® **– a low-priced AISI Type O1 alloy tool steel – because the thin, close-tolerance contact edges withstood over 4-million high speed blows in a life test. No other steel has lasted more than 1-million cycles before chipping and failing.**

3. Cylinder block for a fast acting, aircraft hydraulic pump made of Crucible Chrome tool steel. **Pump operates at temperatures up to 500 F, pressures to 5,000 psi. Tool steel was selected over a standard AISI alloy because of its high degree of cleanliness, uniform response to heat treatment, and controlled hardenability. Furthermore, because tool steel practices are employed in making it, the steel more consistently meets the critical mechanical and physical properties required in this application.**

For data sheets on these and all other Crucible tool steels – send the coupon.

High Boron Stainless Steels Made Possible by Vacuum Melting

Type 304 stainless steel with boron has proved to be an excellent material for nuclear equipment, because the boron readily absorbs neutrons. By increasing the boron content, valuable weight and thickness reductions can be made in reactor shielding and control rods.

Unfortunately, conventionally melted borated 304 becomes "hot short" – virtually impossible to work if the boron content exceeds 1%. Vacuum melting has provided the answer to this problem. Vacuum-melted 304 stainless is readily workable when the boron content goes up to 2% or even higher.

Vacuum melting the alloy also provides closer control of the composition, because only pure materials are used. So, undesirable elements such as cobalt – which becomes radioactive upon bombardment – can be kept to a minimum. In fact, vacuum-melted Type 304 stainless can be supplied with less than .001% cobalt.

For additional information on vacuum-melted steels – send the coupon.

CRUCIBLE STEEL COMPANY OF AMERICA
Dept. EK-07, The Oliver Building
Mellon Square, Pittsburgh 22, Pa.

Gentlemen:
Please send me the following:
1. Data sheets on B-120VCA ☐ C-105VA ☐ C-115AMoV ☐
2. A copy of "Titanium Alloys for Aircraft and Spacecraft" by Finlay, Vordahl and Malone ☐
3. Data Book on Crucible tool steels ☐
4. Data sheets on vacuum-melted steels ☐

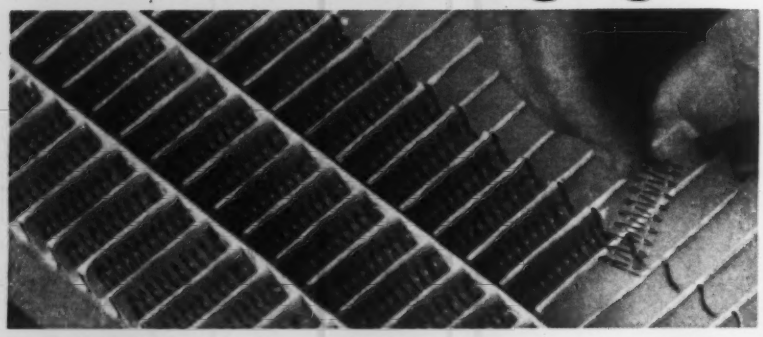
Name_____ Title_____
Company_____
Street_____
City_____ Zone_____ State_____

CRUCIBLE STEEL COMPANY OF AMERICA

*Reg. Trade Mark

Circle 430 on Page 19

NOW...eliminate tangling...



SAVE assembly time . . .

cut costs, speed operations with . . . Spring Flow®

Spring Flow brings springs, wire forms, and other fabricated-metal parts into your plant packaged for efficient production. No need to waste time untangling—no distortion. Shape and finish are protected in use or storage. Inspection and selection is easier, faster. Special packaging or dispensing speeds up hand or automatic assembly.

Spring Flow cost is frequently offset by resulting savings. Here's how to find out. Show us your spring or metal part and how it is used in your plant. Let us submit a Spring Flow recommendation. Or write for booklet giving more details about Spring Flow.

8909

Associated Spring Corporation

General Offices: Bristol, Connecticut

Wallace Barnes Division, Bristol, Conn. and Syracuse, N. Y.
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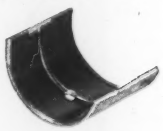
LOW COST BUSHINGS with Bearing Performance!

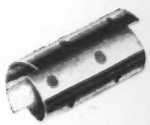
Bimetal bushings, in a variety of alloys on steel, provide bearing load-carrying qualities, *with the advantages of low-cost production*. Quality-controlled manufacturing to your specifications. Complete engineering service. Write:

FEDERAL-MOGUL DIVISION

FEDERAL-MOGUL-BOWER BEARINGS, INC., 11045 SHOEMAKER, DETROIT 13, MICHIGAN

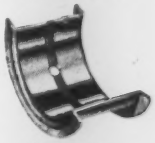


Copper-Alloy Lined



Spacer Tubes

Bearing-Surfaced Thrust Washers



Aluminum or Babbitt Lined

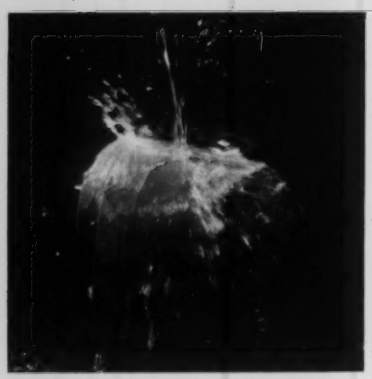
FEDERAL Mogul SINCE 1899

RESEARCH • DESIGN • METALLURGY • PRECISION MANUFACTURING

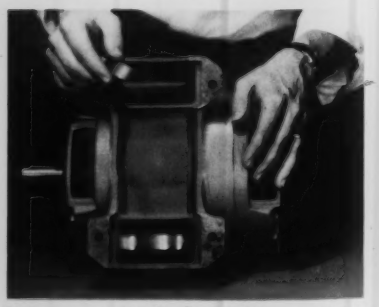
Circle 432 on Page 19

Circle 433 on Page 19→

Get faster assembly–more dependable

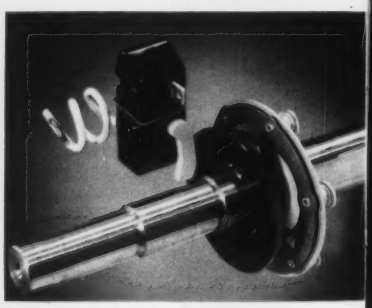


Better Protected against dripping or splashing liquids, this G-E motor is suitable for many jobs where an ordinary dripproof motor cannot be applied.



Base-mounted Capacitors eliminate bulky capacitor "top hat," are safe from physical damage. Easy-to-remove spring clips hold capacitors in place.

Perma-Numbered Leads are always easy to identify. Non-wicking neoprene insulation prevents moisture from running up leads into vital parts.



Totally-enclosed Transfer Switch assures positive contact and long life—over 1,000,000 consecutive operations on test.

operation for your products . . .

WITH GENERAL ELECTRIC TRI 55 CLAD SINGLE-PHASE MOTORS

HERE'S WHY:

Perma-numbered leads in the G-E Tri/Clad '55' motors make connection easier because they are easy to identify. Threaded conduit entrance eliminates need for internal lock nut . . . faster installation results. And rigid cast-iron frame and endshields prevent motors from being twisted out of line during assembly operations—make machine operation more dependable.

THE SMALL SIZE AND LIGHT WEIGHT of Tri/Clad '55' standard motors facilitates installation on your products; helps reduce mounting and shipping costs *without* sacrificing full-power performance. Also, G.E.'s dripproof design allows these single-phase motors to be used for many applications which normally require splashproof type motors . . . you save money.

FOR LONGER MOTOR LIFE, G-E Tri/Clad '55' motors feature Mylar* polyester film insulation, Formex† magnet wire, water-resistant stator coating, and better physical protection. Longer motor life, of course, results in longer life and increased dependability for your products.

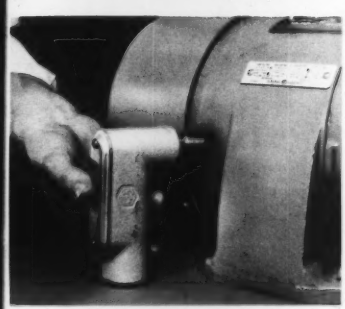
COMPARE G-E Tri/Clad '55' motors with other makes of motors. Remember: (1) General Electric offers you a complete line of single-phase motors to choose from . . . dripproof or enclosed, vertical or horizontal, C-face or D-flange, all of which meet NEMA standards. (2) You'll also be pleased with the *exceptionally* fast delivery you can get and with G.E.'s small motor service station plan . . . a real plus in cementing customer relations.

CONTACT your local G-E Apparatus Sales Office now for personal proof of how these G-E motors can help cut your costs, reduce assembly time, and give longer-life operation. And ask for your free copy of illustrated bulletin GEA-6240, or write Section 840-18, General Electric Company, Schenectady 5, New York.

*Registered Trade-mark of DuPont Co.

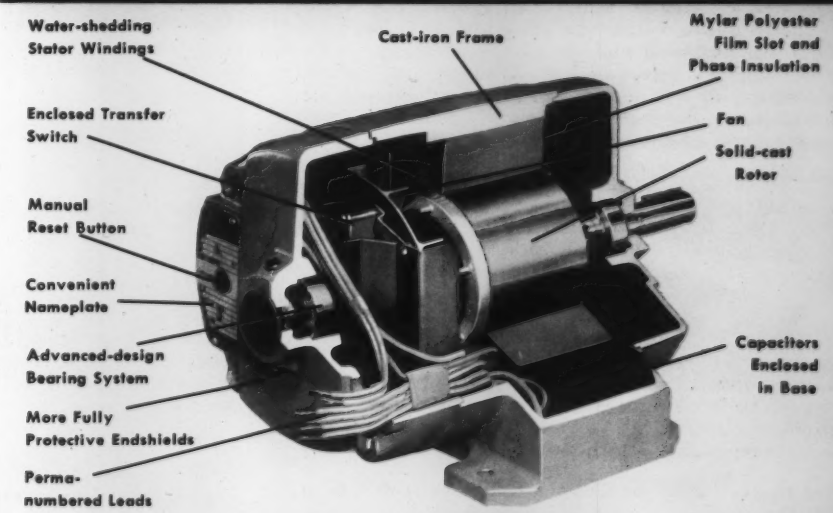
†Registered Trade-mark of General Electric Co.

GENERAL ELECTRIC



Threaded Conduit Entrance permits quick, easy installation; provides tighter, dust-proof seal for conduit.

SINGLE-PHASE TRI CLAD MOTORS OFFER THESE TIME AND MONEY SAVING FEATURES



Standard single-phase Tri/Clad '55' motor

News and Notes on...
Good Packing Practice

JOHNS-MANVILLE JM PRODUCTS

Maintenance and Design Hints from Johns-Manville Packings and Textiles Dept.

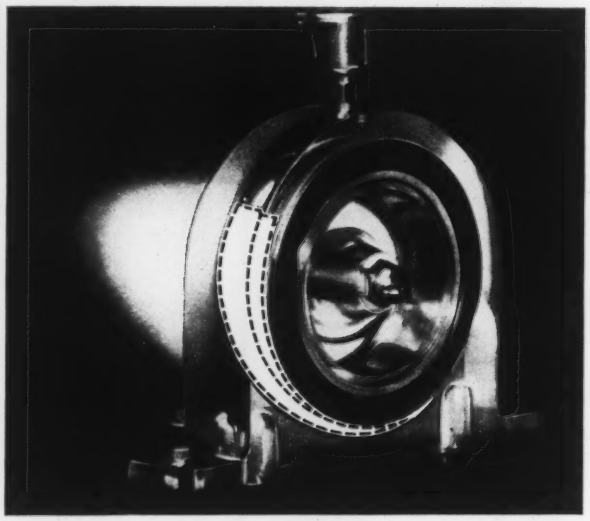
Subject of the month: Effective Shaft Sealing

Question: What is an economical way to seal in or seal out with maximum efficiency?

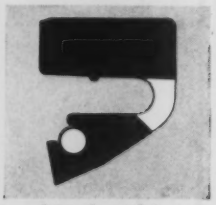
Whether the shaft bearing is of the sleeve, roller, or ball type . . . seals should meet two basic requirements: (1) provide a tight seal despite light applied pressure, and (2) resist abrasion and corrosion.

The transparent unit shown at the right was created by research engineers to study this subject of effective sealing . . . witness the performance of J-M seals in development stages. It helped them perfect the versatile, dependable line of J-M Clipper® Seals that serve many industries.

In this unit, Clipper Seals are mounted on a transparent cylinder, just as in a bearing cavity. The heel of the seal provides the rigidity essential for a press fit. The lip is flexible and soft so as to snug the shaft with a minimum of friction. Thus it acts like a gasket and effectively stops leakage.



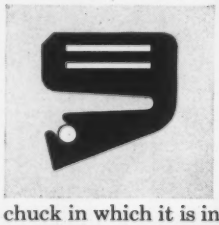
HERE ARE JOB-TESTED RECOMMENDATIONS FOR COMMON SEALING APPLICATIONS:



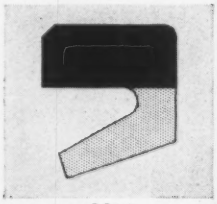
For General Service—Type LPD All Purpose. This line-contact Clipper Seal provides long life and maximum sealing effectiveness under a wide range of equipment variables. Its synthetic rubber base compound is recommended by J-M for most sealing lip applications where combined ambient and operating temperatures reach 250°F and higher. It seals practically all fluids . . . has proved highly effective against oils and greases, hot and cold water, air and many other gases and vapors. And it maintains its high efficiency despite time, high temperatures, and adverse conditions.

For Small Clearances—Split Clipper Seals. Split Clipper Seals have wide acceptance as temporary replacement seals for equipment with space or design limitations . . . to save costly downtime. Installation in inaccessible space is relatively simple and speedy. They are practically fracture-proof . . . stand up under the rough treatment . . . can be forced into position around the shaft. They give long-term, efficient sealing until a major overhaul permits replacement with solid seals.

For further data on Clipper Seals write for Book PK-71A. Address: Johns-Manville, Box 14, New York 16, N. Y. In Canada: Port Credit, Ontario.



For Continuous High Speed Operations—Type LPD Metal-Reinforced. This Clipper Seal, incorporating a metal reinforcement, is ideal for use in continuous high speed and extremely abusive service such as encountered in the steel industry. It expands and contracts with the chuck in which it is installed. It is a combination of two synthetic rubber base materials that are highly resistant to cracking, hardening and shrinking.



For Small Shaft Diameters—Type SS Springless. Here's the Clipper Seal designed for smaller cavities. It is made of a selected synthetic rubber base compounded to minimize swell and deterioration in corrosive applications where chlorinated solvents, lubricating oils carrying severe additives, or similar aggressive fluids must be sealed. It is a complete part in itself—contains no metal spring. No spring is required because this seal is designed to exert sufficient lip interference on the shaft to compensate for wear over a long period of time.

JOHNS-MANVILLE

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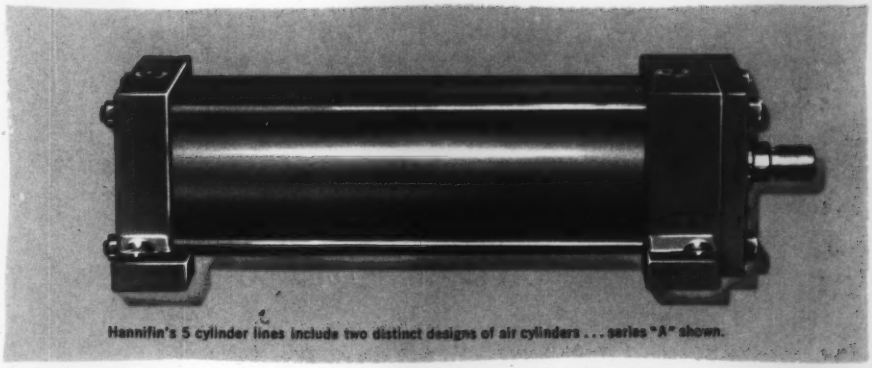
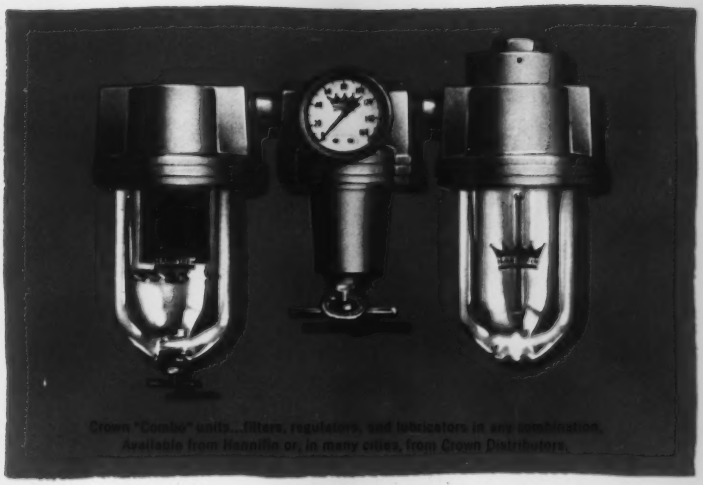
Circle 435 on Page 19 for Air Power Products→

PARKER-HANNIFIN FLUID-SYSTEM COMPONENTS

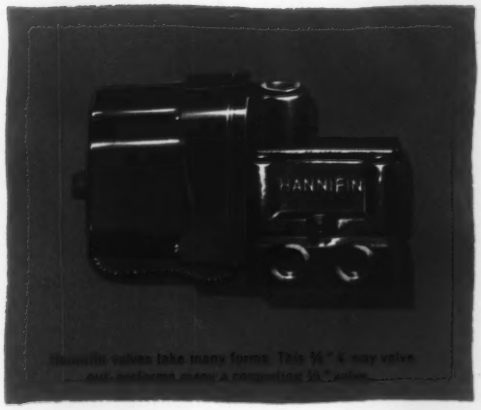


Hannifin's 5 cylinder lines include two distinct designs of air cylinders . . . series "A" shown.



Crown "Combo" units...filters, regulators, and lubricators in any combination. Available from Hannifin or, in many cities, from Crown Distributors.

Only **HANNIFIN** makes all these **AIR POWER COMPONENTS**



Hannifin valves take many forms. This ¼" 4-way valve out-performs many a competing ½" valve.

Anywhere you use compressed air to do work, Hannifin can help you. Hannifin cylinders for the "muscles". . . Hannifin air valves for any type of actuation, hand, foot, cam, solenoid, or pressure . . . the Hannifin "Crown" Line of filters, regulators, and lubricators for lasting air power efficiency . . . all are built by Hannifin to just one standard, the best.

Turn to Hannifin, too, for expert help in applying air power components. A Hannifin field engineer is as close to you as your telephone, wherever you are. Write us for his address—or, he's listed in the alphabetical section of Thomas Register. It's that easy.

HANNIFIN COMPANY

505 South Wolf Road • Des Plaines, Illinois

A DIVISION OF PARKER-HANNIFIN CORPORATION

a new concept in motor protection!

GET TOTALLY ENCLOSED PROTECTION AT LESS COST WITH STERLICONE MULTI-SHIELDED DRIP-PROOF MOTORS!

STERLICONE MULTI-SHIELDED Motors, an exclusive development of Sterling Electric Motors, Inc., now make it possible to use drip-proof motors with full overload characteristics on many demanding applications... such as food processing, chemical, oil well pumping, and others involving corrosion, salt spray or similar atmospheric conditions that previously required TEFC protection.

STERLICONE MULTI-SHIELDED MOTORS – SHIELDED 5 IMPORTANT WAYS!

1. Flexible insulation is achieved by multiple application and controlled processing of a special silicone sealing compound to provide such a greater degree of environmental protection that these motors can be used for applications involving excessive moisture, salt spray, oils, most chemicals, corrosive agents or dust. Forming a smooth, flexible coil encasement, this insulation is permanently resilient, with high dielectric strength; it does not become brittle like other protective materials.

   Heat dissipation is effected by means of the famous Sterling design of through ventilation. Because *STERLICONE* Shielding is of uniform thickness, heat is readily transmitted from the coils; moreover, since there is no bulky encapsulation, air may pass freely over, under, and around the end coils, resulting in a cool running drip-proof motor.

   This new *STERLICONE* Shielding process has been thoroughly proven. Tested by an independent laboratory under conditions far more severe than would exist in most industrial applications, the performance of this new motor equals or exceeds that of totally enclosed designs.

2. Anti-corrosion coating provides extra protection for both rotor and fan.
3. Neoprene insulation shields all motor leads.
4. Neoprene gaskets and diaphragm seal terminal box against virtually all atmospheric hazards. Terminal box rotates 360° for easy access.
5. Sealed bearings are used... together with grease packing and labyrinth seal on the output shaft... for positive bearing protection and longer bearing life.

For initial savings, longer service life, lower required horsepower ratings and minimum maintenance, *STERLICONE* MULTI-SHIELDED Motors are your best buy. Get the facts about *STERLICONE* MULTI-SHIELDED Motors. Write for Bulletin 196.

STERLICONE MULTI-SHIELDED

STERLING ELECTRIC MOTORS, INC.

5401 TELEGRAPH ROAD • LOS ANGELES 22 CALIFORNIA

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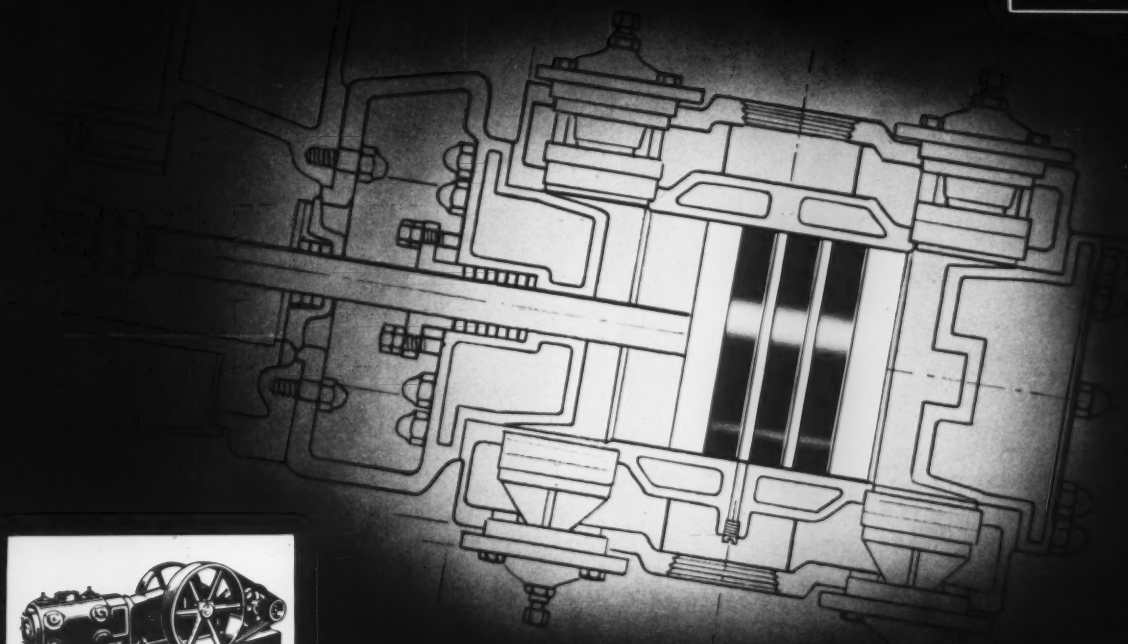
DU PONT

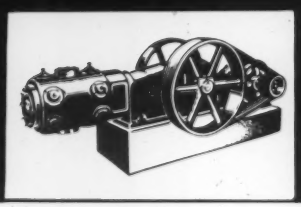
ENGINEERING FACTS ABOUT

TEFLON®

FLUOROCARBON RESINS

Number M-6 in a series
MECHANICAL DESIGN
Floating Rings





Piston rings made with TFE resins cut replacement and maintenance costs

In a heavy-duty compressor, a set of piston rings and wear rings made of filled TFE fluorocarbon resins (shown above) has made possible substantial savings in replacement and maintenance. The rings that were replaced by rings of TFE resins cost two and one-half times as much, and lasted only one week on the average. The rings made with TEFLON TFE resins were still in operation after three and one-half years of service. Maintenance savings according to the manufacturer amount to approximately $3,750 labor/year/machine.

The unique combination of properties offered by TFE resins makes possible improved performance, greater reliability and lower costs in all types of floating-ring applications. TFE resins have the lowest coefficient of friction of any solid materials—less than 0.04. They eliminate problems of stick-slip, and permit the use of non-lubricated rings. In addition, their exceptional resistance to temperature and corrosion makes them ideal sealing materials under adverse conditions. In everyday seal applications as well, floating rings of TFE resins provide longer life, safer and more reliable operation and reduced maintenance problems.

On the next page you will find additional information on the properties of TFE resins that make them advantageous for use in floating rings and additional data on the opportunities they provide for improved seal designs.

TEFLON is Du Pont's registered trademark for its fluorocarbon resins, including the TFE (tetrafluoroethylene) resins discussed herein.

OVER

Design of piston rings made with TFE resins

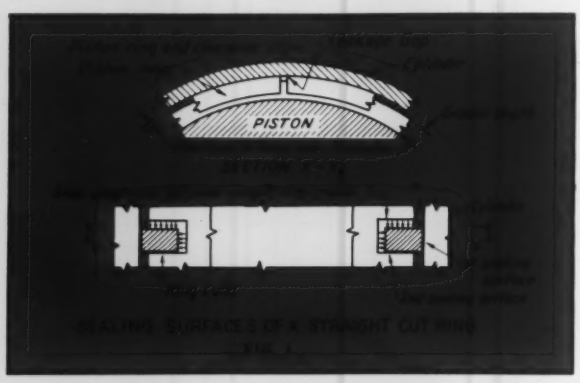
Piston rings and other floating rings are used to seal reciprocating, oscillating and rotary motions of both external and internal cylindrical surfaces against the leakage of fluids. Split floating rings, with an overlapping joint, can handle relatively wide changes of cylinder size caused by thermal changes. High temperatures and pressure have heretofore dictated metallic floating rings; now TFE resins provide ring materials with distinct advantages over metals.

Relevant properties

The static coefficient of friction of TFE resins is even lower than the dynamic value. TFE resins have lower friction than any other solid material, including graphite and molysulfide. They have significantly lower static friction (as low as .016) than the best lubricated metal rings. Rings made with TFE resins have exceptional thermal stability, and maintain their unsurpassed frictional properties from -320°F. to 500°F. They are completely inert to virtually all chemicals and solvents. They are tough and abrasion-resistant, and have the ability to imbed hard foreign particles without damage to themselves or to cylinder walls.

Where to use rings of TFE resins

Piston rings based on TEFLON TFE resins are being used as compressor rings and as hydraulic and pneumatic seals and rings. They perform successfully in areas where lubricated rings are undesirable or cannot operate because of extreme conditions, under highly corrosive conditions, where lubricant failure is possible, where low starting friction and the absence of stick-slip are desirable, where safety and reliability are essential, and, in general, where long, trouble-free performance and reduced maintenance costs are important.



Design considerations

The basic piston ring used in reciprocating service is the split rectangular section shown in Figure 1. Obtaining contact between the sealing surfaces depends on the use of a separate spring, such as a wave washer, or on the action of fluid pressure on the side of the ring. The low friction of TEFLON TFE resins produces a seal against the ring land quicker and at lower pressures than with other ring materials. Various piston-ring joints and multi-piece ring designs have been developed to improve ring sealability. Where wide temperature changes are not encountered and surface speeds are not high, it is not always necessary to split floating rings of TEFLON TFE resins. Since these rings are more resilient than other ring materials, they may be snapped into the groove and compressed into the cylinder upon installation, permitting additional cost savings in mass-production operations. They are available in virtually all sizes.

Life and wear of reinforced TEFLON TFE resins

Ring performance can be greatly improved by increasing the mechanical strength, resistance to wear, dimensional stability and thermal conductivity of these rings by reinforcing the TEFLON TFE resins. Several techniques for reinforcing TFE resins include: filled compositions (both particles and fibers), glass-fabric-reinforced, and metal-reinforced. All these constructions can be tailored to meet specific needs of pressure and velocity. The life and wear rate of piston rings of reinforced TFE resins depend, of course, on a variety of factors. It has been found, however, that reinforced TFE resins are superior to many of the best piston-ring materials used under extreme conditions. It is interesting to note that less wear is experienced using rings of TFE resins with cast-iron or stainless-steel bores than with dense chromium-plated bores. This suggests further opportunities for cost savings.

FOR MORE INFORMATION...

Further details on the properties and design characteristics of TEFLON TFE resins and their application to floating rings may be obtained from your local supplier. Look for him under "Plastics—Du Pont" in the Yellow Pages, or write to: E. I. du Pont de Nemours & Co. (Inc.), Advertising Department, Room T-2511, Nemours Building, Wilmington 98, Delaware.

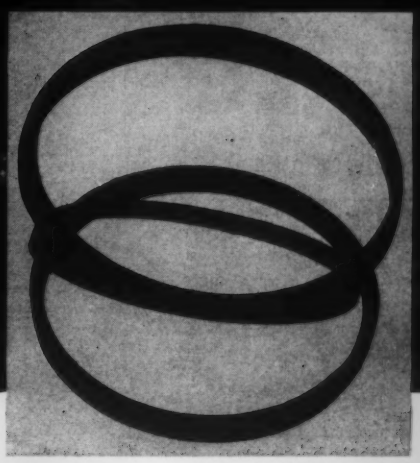
In Canada: Du Pont of Canada Ltd., P.O. Box 660, Montreal, Quebec.

DU PONT TEFLON®

TFE-FLUOROCARBON RESINS

BETTER THINGS FOR BETTER LIVING . . . *THROUGH CHEMISTRY*

VISIT US AT THE CHEMICAL INDUSTRIES EXPOSITION, NEW YORK CITY, NOV. 30 TO DEC. 4, BOOTHS 1295 AND 1297



SAFETY...the plus value of Dore' Fluorogreen Rings on Pump and Compressor Pistons

Cylinder lubricants required for pistons using conventional iron rings contaminate the commodity, creating troublesome and frequently unsafe operating conditions. Dore' Fluorogreen Rings, requiring no lubrication, automatically eliminate contamination and its subsequent problems.

Prior to installation of Dore' Fluorogreen Rings in this 12" x 6½" x 18" steam pump, steam cylinder lubricating oil was contaminating the condensate, causing deposits in the lines of the heat exchanger and the boiler tubes. The oil film in the heat exchanger reduced pre-heating efficiency of the condensate and insulated the soft plugs in the boilers, causing a danger that can be avoided by keeping condensate free of contamination due to lubricants. There has been no danger of a high temperature, high pressure steam blowout during the 13,683 hours of continuous operation without lubrication.

In addition to the SAFETY and SAVINGS brought about by the elimination of contamination, these non-lubricated rings show no sign of wear after these thousands of hours of service. The cylinder walls are highly polished with a glass smooth finish and the rings are still in operation.

In other applications such as air, oxygen, nitrogen, ammonia, chlorine gas and H_2S contaminated petroleum gases, Dore' Fluorogreen Rings have proven their economy, dependability, performance and safety far exceeds that of other type piston rings for these services.

Fluorogreen is an exclusive Dore' development, consisting of Teflon scientifically compounded with micro sized glass fibre, and a special compounding agent which insures completely uniform density and the prevention of soft spots usually found in conventional glass filled Teflon. Fluorogreen Rings have hardness for maximum wear resistance, plus the lowest coefficient of friction of any solid material for non-lubricated operation.

Dore' Fluorogreen Rings have exceptional thermal stability from room temperature to 400 deg. F. They are available in one piece step-cut and segmental types, in diameters up to 30 inches.

Resistance to temperature and corrosion makes Fluorogreen Rings applicable to pump and compressor pistons in an almost limitless range of services. Our engineering staff will cooperate with you in the solution of any unusual or difficult pump or compressor ring problem.

Additional information on the properties, design and service applications of Dore' Fluorogreen Rings is available on request. Write for Data Sheet FGR-859.

Teflon is Du Pont's registered trademark for fluorocarbon resins. Fluorogreen is a John L. Dore' Co. registered trademark.

John L. Dore' Co.

5406 Schuler • P. O. Box 7772 • Houston 7, Texas
Export: 1505 Race St. • Philadelphia 2, Pa., U.S.A.
Cable Address: DOREX

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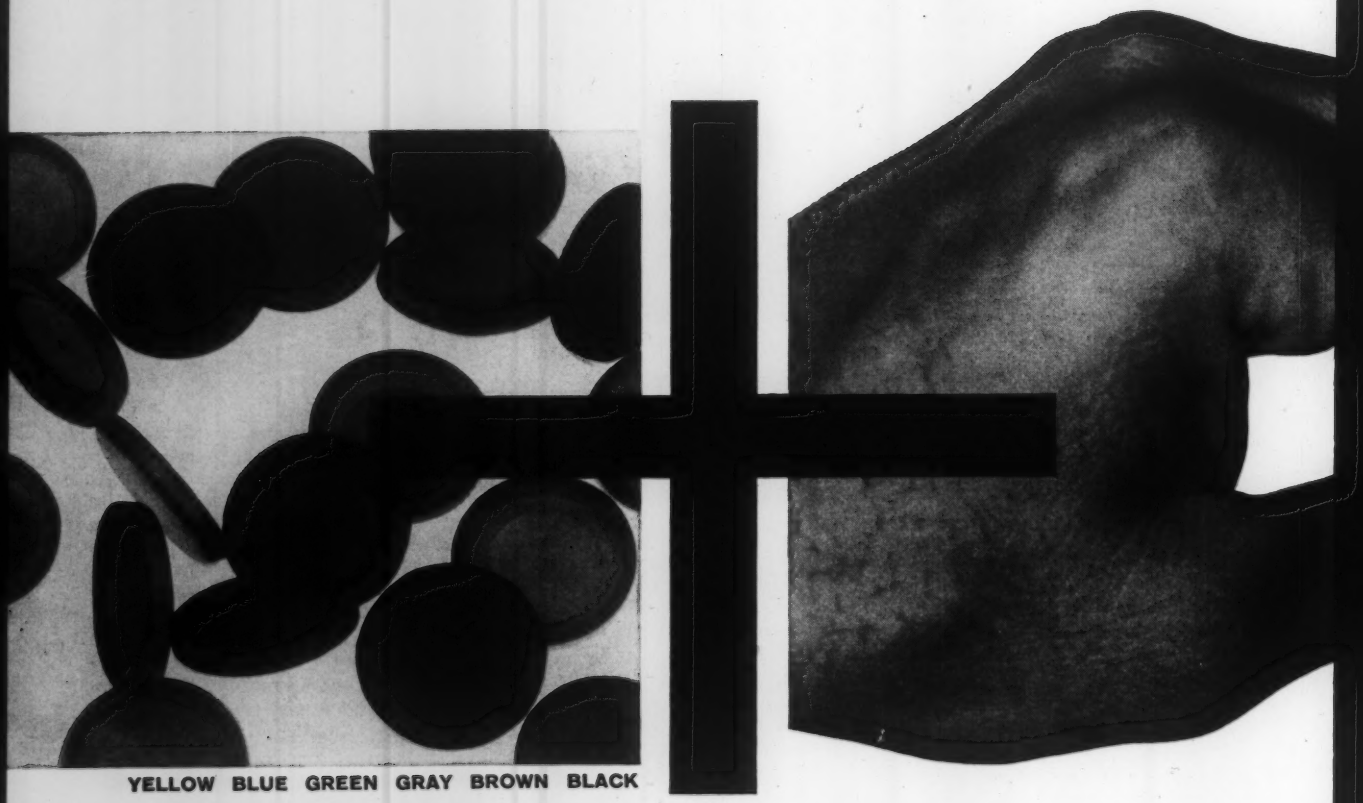
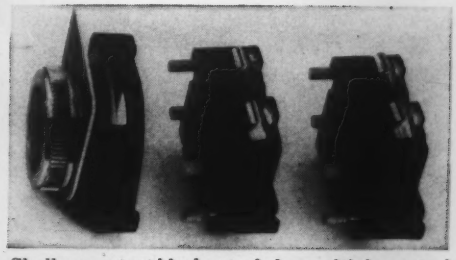
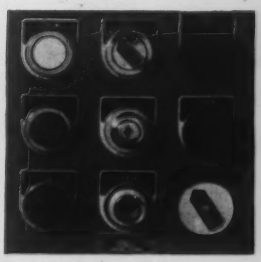


YELLOW BLUE GREEN GRAY BROWN BLACK

WESTINGHOUSE FLUSH PUSHBUTTON puts the finger on color coding with snap-on color caps !



Shallow contact blocks stack for multiple control circuits. Angled terminals are easy to get at with a screwdriver, even when blocks are stacked.



Available in a full range of operator designs.

HERE'S PRACTICAL PUSHBUTTON COLOR CODING—the economical Westinghouse way. Snap-on color caps let you change colors *without changing buttons.* Simply remove the clamp ring and color caps snap off easily and can be replaced in a matter of seconds.

Simplified color coding is but one of the many pluses for new Westinghouse flush pushbuttons. Thin operator and shallow contact blocks make this pushbutton *thinnest overall.* Contact blocks stack for control of multiple operations, another space-saving feature.

Flush pushbuttons are oiltite, of course. And they meet exacting machine tool and control panel requirements. Available in a full range of operator designs.

Regardless of your pushbutton requirements, order with confidence from industry's most extensive line. Contact your nearby Westinghouse sales office or distributor, or write: Westinghouse Electric Corporation, Standard Control Division, Beaver, Pa.

J-30304

YOU CAN BE SURE...IF IT'S **Westinghouse**

WATCH "WESTINGHOUSE LUCILLE BALL-DESI ARNAZ SHOWS" CBS TV FRIDAYS

Circle 439 on Page 19

let your imagination run wild

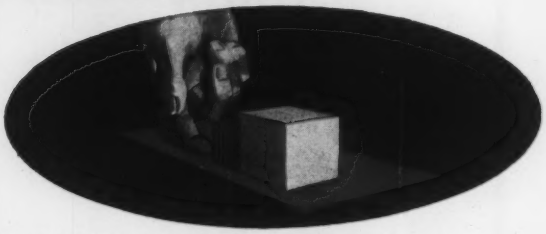
with this coating

EMRALON . . . Acheson's revolutionary new dispersion "opens the door" to a host of "restricted" applications

Five years in development, 'EMRALON' surface coatings now make possible the application of Du Pont Tetrafluoroethylene (TFE) to heat sensitive materials such as aluminum, rubber, wood and plastic. Applied by spray, these versatile resin-bonded lubricating films exhibit the low-friction properties of the TFE pigment together with the durability of their specially-selected binders. Thus, hundreds of potential uses which heretofore were impractical because of the high fusing temperature of other processes, can now be reconsidered as workable applications.

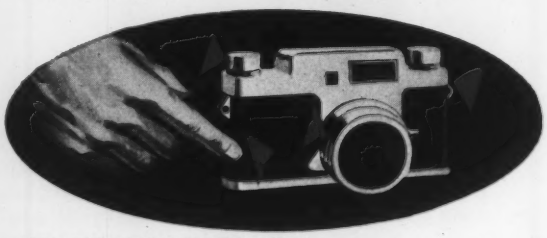
First in the Acheson family of TFE dispersions is 'EMRALON' 310,* employing a phenolic binder. Requiring a one-hour cure at only 300°F., it provides an unparalleled combination of low-friction coefficient, toughness, flexibility, adhesion and corrosion resistance. Substrates even more sensitive to temperature, or those where a bake cure is not practical, can be coated with 'EMRALON' 320† air-drying counterpart to 'EMRALON' 310.

Evaluate 'EMRALON' 310 or 320 in your plant and be among the first to "open the door" to new design possibilities. Send for an introductory package complete with data sheet. Enough to coat 5,000 sq. in. of surface is yours for $4.25 prepaid ($4.50 west of the Rockies). Write today.



LOW COEFFICIENT OF FRICTION

MAY BE APPLIED TO HEAT-SENSITIVE MATERIAL



IDEAL FOR LIGHT LOAD MECHANISMS

Acheson Colloids Company

Dept. MD-119, Port Huron, Michigan

Gentlemen: Your new 'EMRALON' surface coatings suggest themselves as possibilities for a current design problem. Send an introductory package to me promptly.

- ☐ 'EMRALON' 310 (bake type)
- ☐ 'EMRALON' 320 (air-dry)
- ☐ Bill me on Order No._____
- ☐ Check enclosed
- ☐ Please have your service engineer call:

NAME: TITLE:

COMPANY:

ADDRESS:

CITY: STATE:

APPLICATION:

*'EMRALON' 310 is manufactured under exclusive license from E.I. du Pont de Nemours & Co. (Inc.) under U. S. Patent 2,625,706. Not licensed for use or for sale for use in providing electrical insulation.
†'EMRALON' 320 — Patent applied for

ACHESON *Colloids Company*

PORT HURON, MICHIGAN

A division of Acheson Industries, Inc.

Also Acheson Industries (Europe) Ltd. and affiliates, London, England

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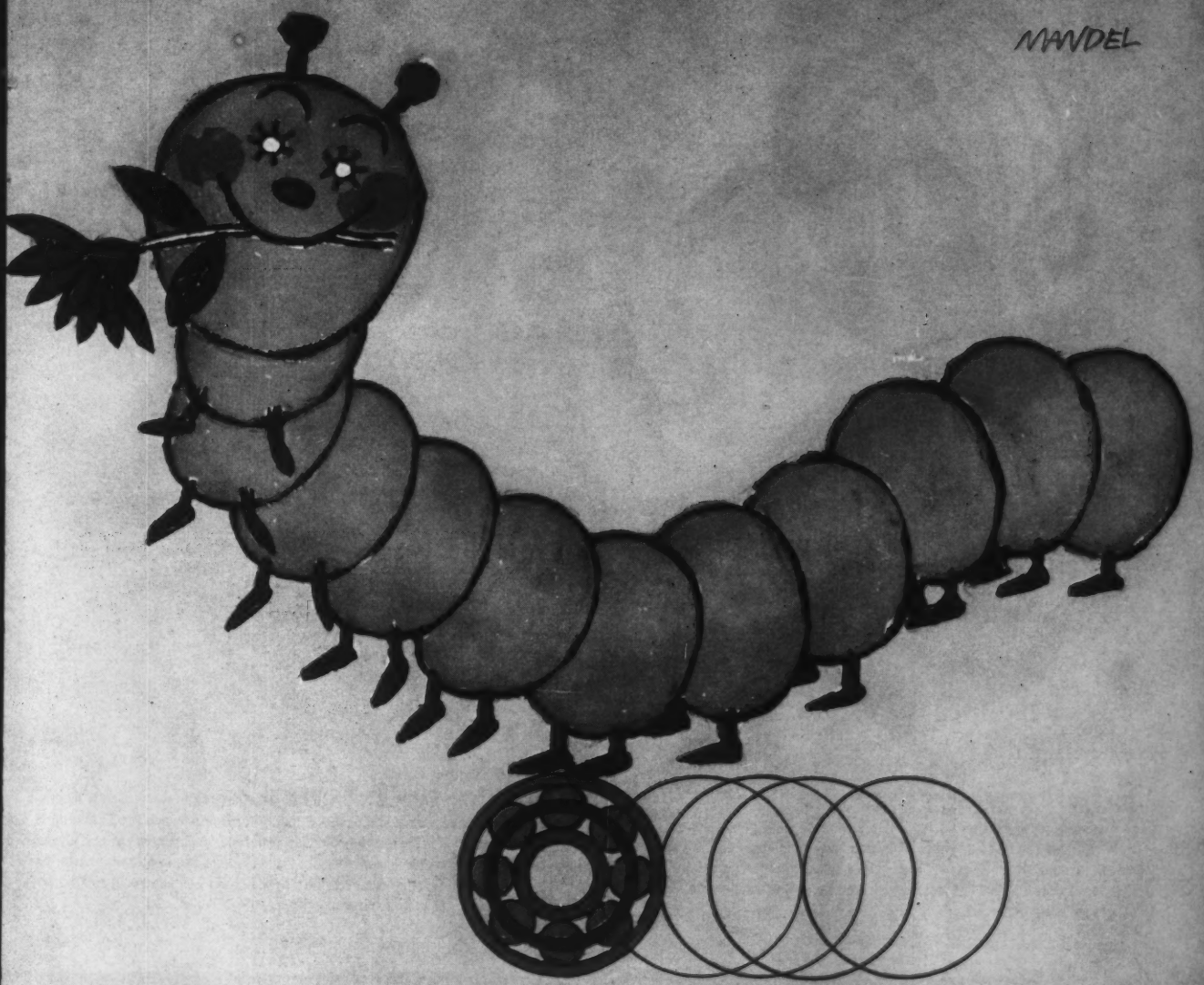

SMOOTH RUNNING

A bearing that turns with the greatest of ease is the bearing that's always certain to please (if you'll pardon our breaking into rhyme). And here at Federal we know that if a finished ball bearing pleases *us*, it's bound to please you. That's why Federal inspectors are such holy terrors when bearing parts reach their quality control points. And if the parts get through, the assembled product is sure to be a ball bearing that will purr sweetly—now and practically ad infinitum. So the next time you want to smooth out a rough anti-friction problem, let Federal Ball Bearings do it for you. You'll find over 12,000 ball bearing sizes and hundreds of types in our catalog. Send for it today.

THE FEDERAL BEARINGS CO., INC., Poughkeepsie, N. Y.

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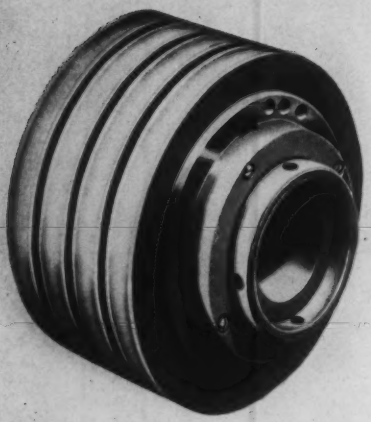
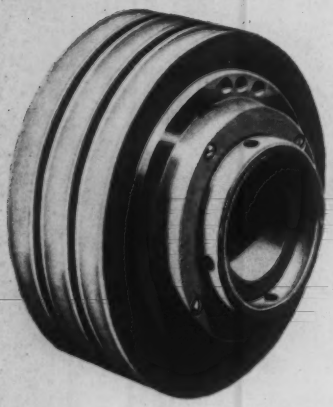
BALL BEARINGS

One of America's largest ball bearing manufacturers

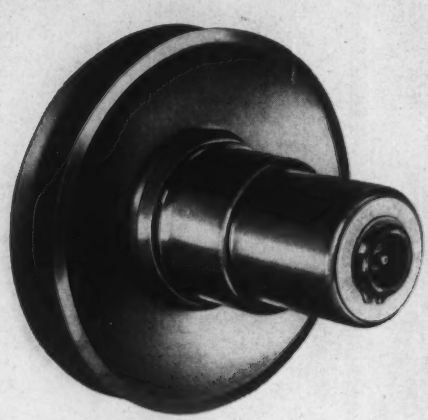
FEDERAL ON FILM—A 16 mm. color sound film takes you through our 400,000 sq. ft. plant. Loaned free. Just ask for it.

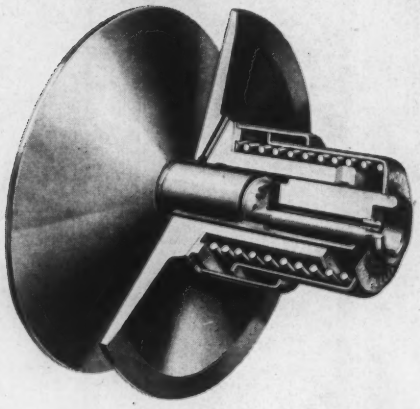




MULTI-PITCH SHEAVES. By adjusting movable flanges, you can provide larger or smaller pitch diameters on these multi-pitch sheaves. The adjustment can be made either when stationary (Stationary Control) or when in motion (Motion Control). They have a speed variation up to 2 to 1 on drives of from 1 to 600 hp. Motor bases are available to compensate for changes in center distances.

SPEED VARIATION 2:1



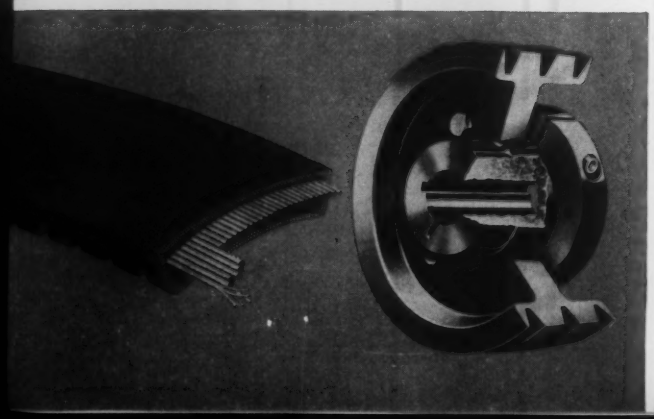


MOTOR PULLEY DRIVES. Worthington's new variable motor-pulley drives combine the efficient power transmission of a V to V drive with the industry's simplest motor-pulley designs for dependable low-cost power transmission with maximum hp. capacities. Ratios 3 to 1 hp. ratings ⅛ to 15. Angle-Matic motor base automatically maintains belt alignment and allows use of true V-groove companion sheave.

3:1

SOMEWHERE ON THIS LINE

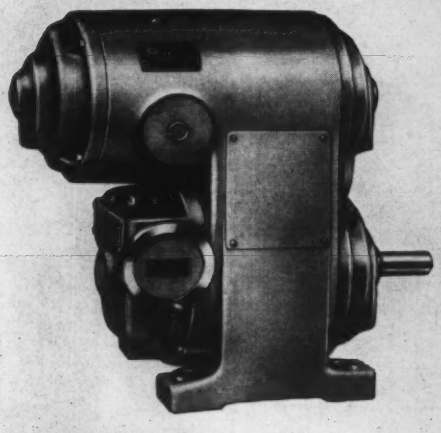
YOU'LL FIND THE ANSWER TO YOUR

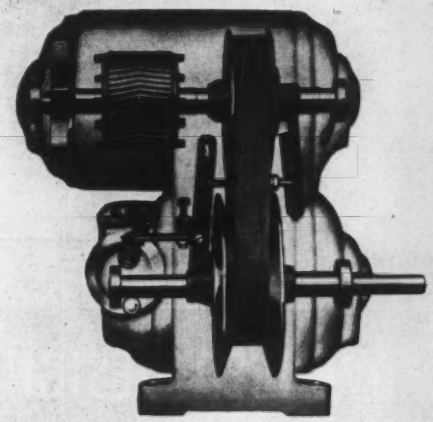


Sound V-belt engineering practice was used throughout Worthington's line of mechanical variable speed drives. They feature compact design, accurate speed control and long belt life.

The line consists of multi-pitch sheaves, motor pulley drives, motor drives, and allspeed drives which handle speed variations up to 20 to 1 and horsepowers from ⅛ to 600.

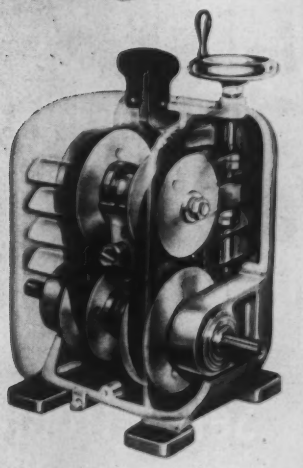
COMPANION SHEAVES AND VARIABLE SPEED BELTS are available from Worthington for use with multi-pitch sheaves and motor pulleys. All companion sheaves are equipped with the famous QD hub with the "Golden Screws." Oil-resistant, static-dissipating construction is standard for all Worthington variable speed belts.





MOTOR DRIVES. Positive pulley adjustment provides accurate speed control. Once you set the speed, the pulley holds it, regardless of varying load. Other benefits include: belt tension in proportion to load, giving extended belt life; compact design and transmission of full rated horsepower. Available in ratings from ½ through 25 hp. with speed variations up to 10:1.

10:1



ALLSPEED DRIVES. Not one, but two belts are used, resulting in an extremely compact unit. This "Twin-V-Tandem" design also gives a very wide speed variation (up to 20:1). Because of positive pulley adjustment, speed control is very accurate. Available in ratings from ⅓ through 5 hp.

20:1

VARIABLE SPEED PROBLEM

For more information about Worthington's complete line of variable speed drives, get in touch with your nearest Worthington representative or distributor. Or mail the coupon at right.

Circle 442 on Page 19

WORTHINGTON

WORTHINGTON CORPORATION
Section 79-16, Oil City, Pa.

Please send me your new catalogs on the following variable speed drive components:

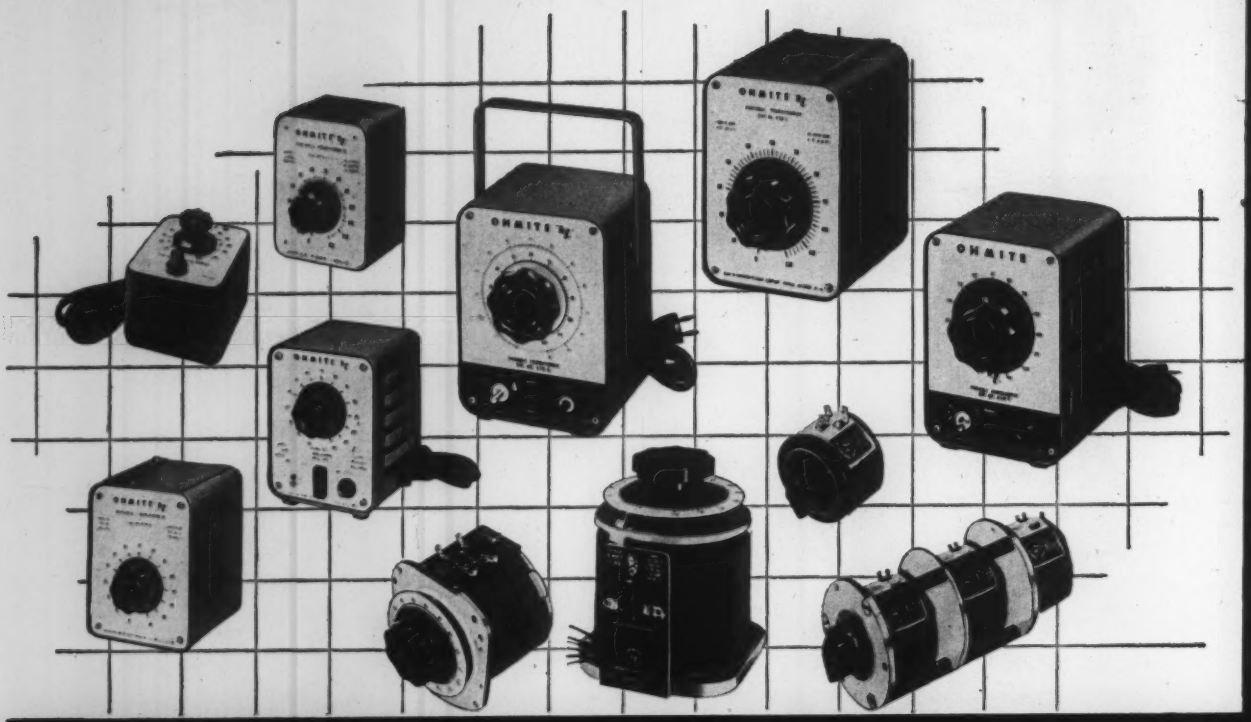
- ☐ Multi-pitch Sheaves
- ☐ Motor Pulley Drives (1 to 15 hp.)
- ☐ Motor Pulley Drives (FHP)
- ☐ Motor Drives
- ☐ Allspeed Drives
- ☐ Variable Speed V-Belts

NAME_____

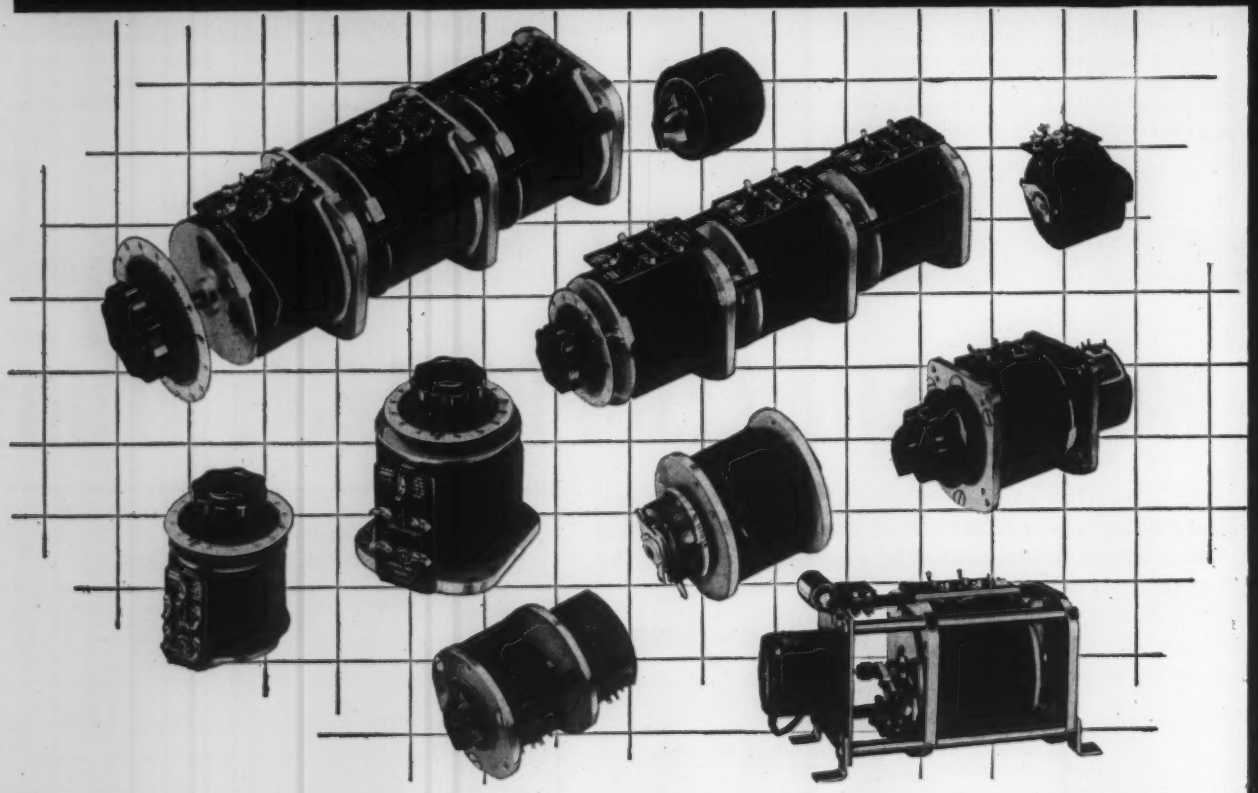
COMPANY_____

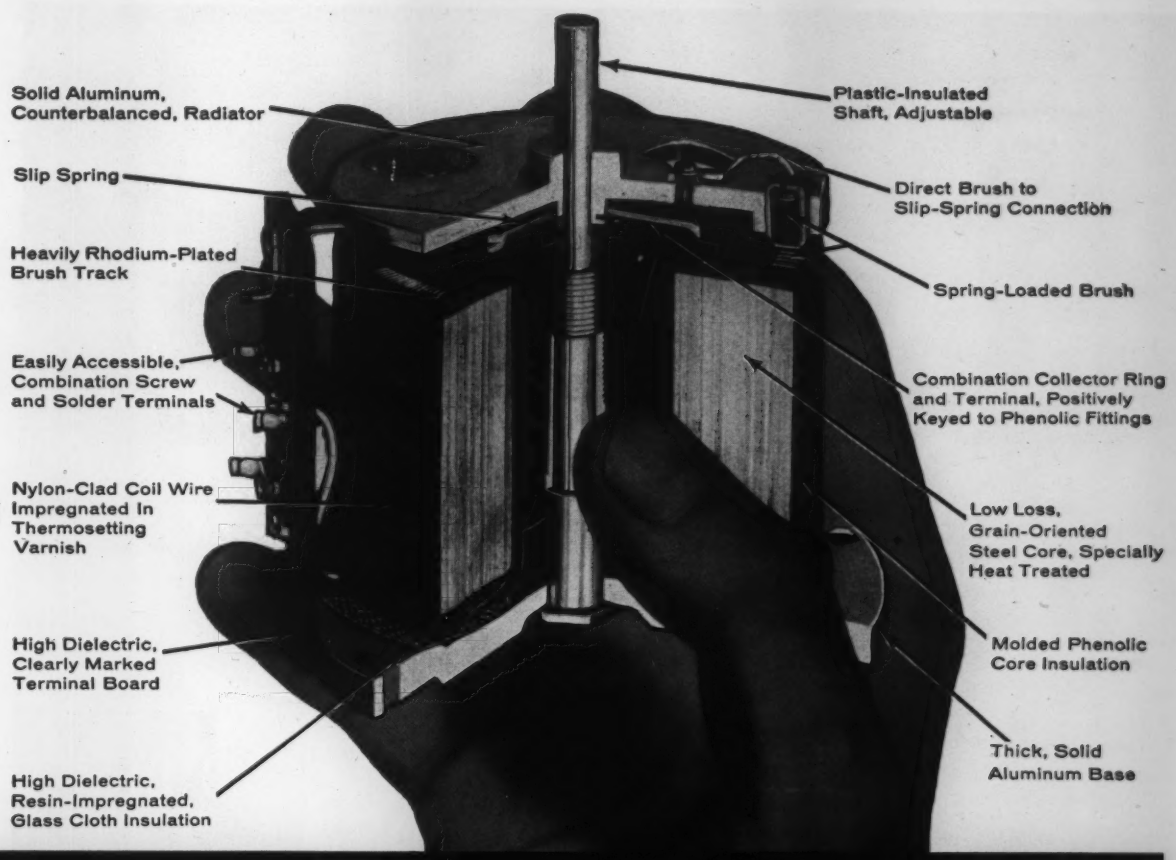
ADDRESS_____

CITY AND STATE_____



Select from the Line with ADVANCED DESIGN





OHMITE v/ VARIABLE TRANSFORMERS

By combining a fresh approach in design with traditional Ohmite quality, "v.t." variable transformers offer convenience features and performance not found elsewhere. They offer top efficiency and high output for their size. Through Ohmite's engineering design, a sizeable bonus in output is available in the "no-overvoltage" types where voltages above line voltage are not required. These units deliver rated output current at *any* brush setting . . . freedom from wave-form distortion . . . excellent regulation at any point within the rated load . . . unusually long life . . . smooth, maintenance-free operation. They are interchangeable with other makes. Adjustable shafts permit ready conversion to table or panel mounting. Offered in a diversified choice of cased models.

Moreover, you can get fast delivery from stock on 35 different models covering ratings up to 10 amps. Or, if you desire, select your special requirements from the many modifications possible. Among these are special windings, custom enclosures (including "explosion-proof"), motor-driven assemblies, auxiliary switches, numerous shaft styles, special tandem units, and combination assemblies with other components.

On your next order for variable transformers, try the line with *advanced design*—Ohmite.

Be Right with OHMITE®
Quality Components

OHMITE MANUFACTURING COMPANY
3618 Howard Street, Skokie, Illinois
RHEOSTATS • RESISTORS • RELAYS • TAP SWITCHES
R.F. CHOKES • VARIABLE TRANSFORMERS
TANTALUM CAPACITORS • GERMANIUM DIODES

Circle 443 on Page 19

The Temperature Control Designed for Fast

"DO IT YOURSELF" MAINTENANCE

Right on the Job!

Rugged simplicity of design—along with the direct, positive power of mercury-actuation — combine to give Partlow maintenance and performance advantages no other type of temperature control can hope to equal.

Simplicity in the Partlow, for one thing, means that the control element can be changed *at the job site* in a matter of minutes with no other tool than a screwdriver . . . "Down time" is cut to an absolute minimum!

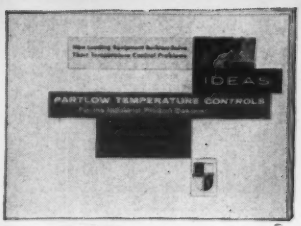
And simplicity in the Partlow also means the complete elimination of fussy electronic gadgets, delicate levers, hairsprings and other accessories that have a tendency to break down at the first trace of jar or jostle. Partlow controls are famous for their unfailingly accurate performance even under the most adverse operating conditions.

If you use or manufacture process equipment within the –30° to 1100° F. range, there's a Partlow pneumatic, electric or self-contained gas control (recording, indicating or non-indicating), to fit your application *precisely*. For details, write The Partlow Corp., New Hartford, New York. Dept. D-119.

You can pay more but you can't buy better than

PARTLOW

TEMPERATURE CONTROLS



FREE!

SEND FOR NEW "IDEAS" BROCHURE

This colorful, fast-reading brochure highlights a few of the applications . . . both common and unusual . . . of Partlow Temperature Controls.

It has particular value as a possible "idea starter" for everyone concerned with designing and engineering your product line.

For Free Brochure, circle 444 on Page 19. Or write us direct.

Expert Ad. Auriema, Inc., 85 Broad St., New York 4, N. Y.

The new LICON® line . . . precision switches for every need

In the new, broadened Licon line you'll find every switch designed to meet modern high capacity, long life requirements. These are switches built to do today's tough jobs. Typical is the unique Type 16—heart of many Licon switch assemblies—tiny in size but rugged enough to handle big switch loads with unbelievable life. Check the unusual "specs" of the Type 16, and all Licon types, against your switch needs—see and compare Licon life against any switch—we're sure you'll specify Licon. *Send for catalog on new broad Licon line*

—Gives handy dimensional data and engineering specifications you'll want to keep for ready reference.

Type 30 Enclosed Limit Switches—Interchangeable components form up to 10 switch types for [illegible]. High beauty, compact, low-priced. 15A., 125V a-c—for industrial applications.

H—Hermetically sealed Switches—Designed for dependability in extreme environments. Unique, [illegible] moisture and other elements. Designed especially to your application.

Type 14 Heavy-duty Switch—Built for heavy industrial and machine tool service. Rugged snap-[illegible] 30 amps at 250V a-c.

Type 10 Long-life Basic Switch—New Serpentine action mechanism delivers 10 million operations [illegible]. Can be provided with [illegible] differentials as low as .0005". Rated 15 amps.

Type 22 Double-pole, Double-throw Switches—Provide positive control of four independent [illegible] applications—withstands 25G at 2000 cps. Rated [illegible] a-c, [illegible] d-c (res.).

P—Panel mounted Switches—Variety of types—to 8 or more poles—some solenoid reset or map-[illegible] as required.

Type 11 Snap-action Switches—Resist 50G vibration to 2000 cps. Double-break, snap-action [illegible], contact welding and provides greater capacity. Rated 10 amps., [illegible] a-c.

Type 16 Subminiature Switches—Here's big-switch performance in a tiny unit. Only ½" thick. [illegible] d-c ind. Greatest shock- and vibration-resistance of any switch in its class on the market . . . even near trip point.

LICON

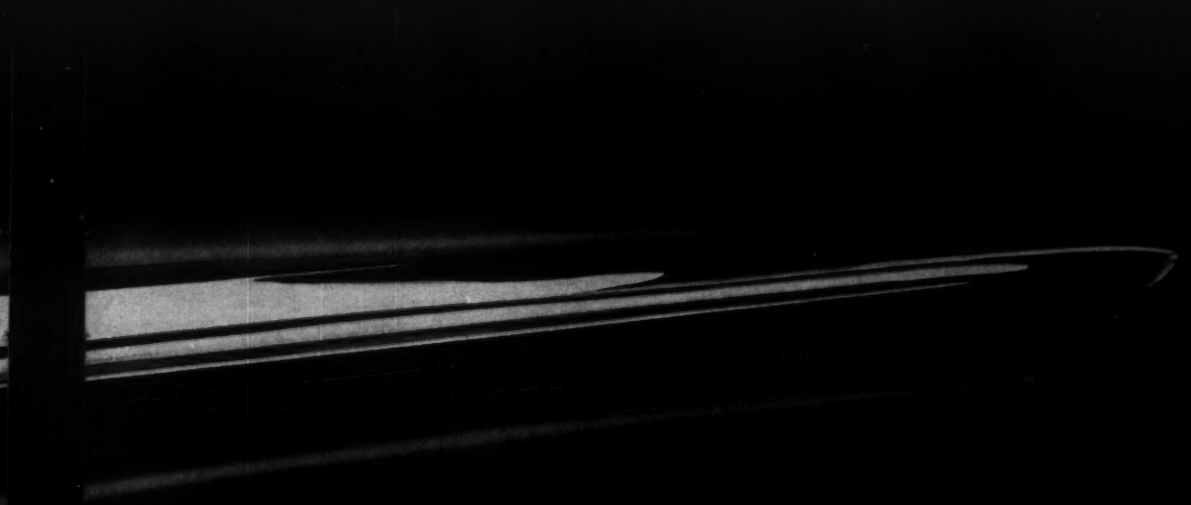
Available through your local Licon distributor.

DIVISION OF ILLINOIS TOOL WORKS

6606 W. Dakin Street, Chicago 34, Illinois

Circle 445 on Page 19

Form your own opinion A missile in flight? . . . A blacksmith's anvil? . . . The tail fin of an automobile?

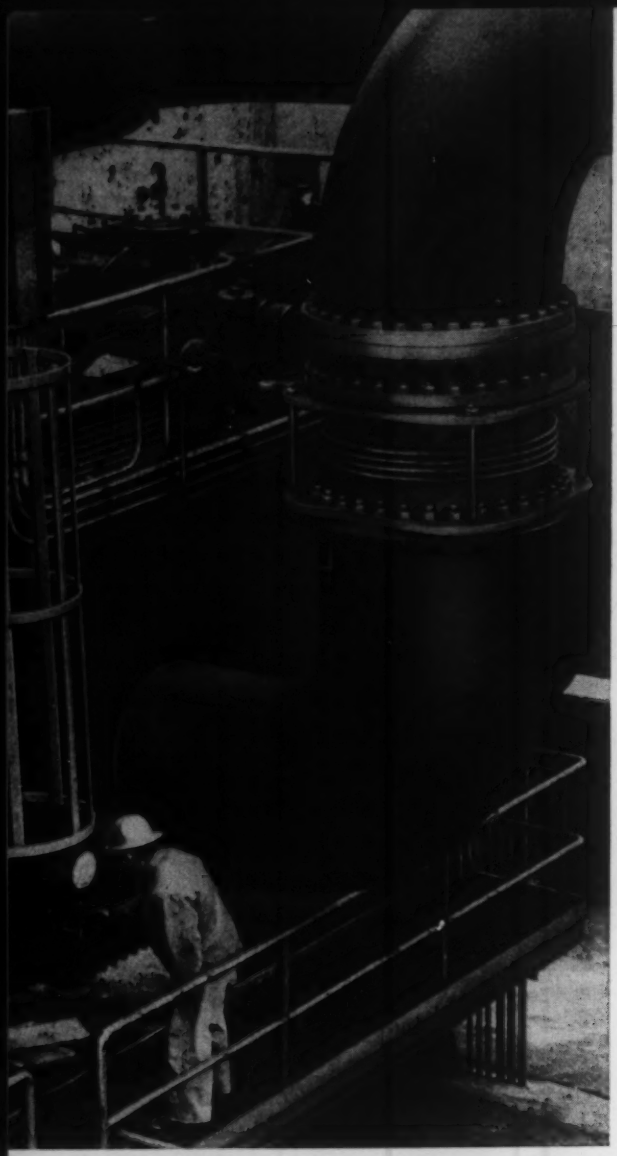


STEELS FOR DESIGN

The "fin" is right—it is made of steel . . . ductile enough to stretch a point, yet strong enough to stand firm.

For some other formable examples of steel, turn the page ▷ ▷ ▷

Please direct inquiries to advertiser, mentioning MACHINE DESIGN



Stainless Steel An expansion joint in a piping system absorbs movement which might otherwise result in reduced life or even complete destruction of vital equipment and piping. One of the best types is the flexible, corrugated Stainless Steel bellows type as manufactured by Zallea Brothers of Wilmington, Delaware.

To produce these bellows, a sheet of Stainless Steel is rolled into a cylinder and welded lengthwise by special automatic equipment. This cylinder is then formed within steel dies by imposing internal hydraulic pressures as high as 4500 psi while compressing the cylinder. The smoothly shaped, cold formed bellows which results are capable of absorbing many cycles of compression, extension, rotation or lateral deflection. Because the bellows are Stainless Steel, they are corrosion resistant, maintenance-free, and capable of prolonged service under severe temperature and pressure conditions.

USS "T-1" Steel Shaped like a giant seashell, a turbine scroll case must withstand tremendous pressure. Water gushes through the conch in an ever-tightening spiral before shooting into the blades. Chicago Bridge & Iron Company used USS "T-1" Constructional Alloy Steel for the shells of four of the largest scroll cases in the Noxon Rapids Dam in Montana. Because of the exceptional strength of "T-1" Steel—115,000 psi minimum tensile strength—the walls could be made nearly 50% thinner and 50% lighter than carbon steel walls. Freight costs were lower. And because there was considerably less weight, the foundations for the cases could be made lighter and less expensive.

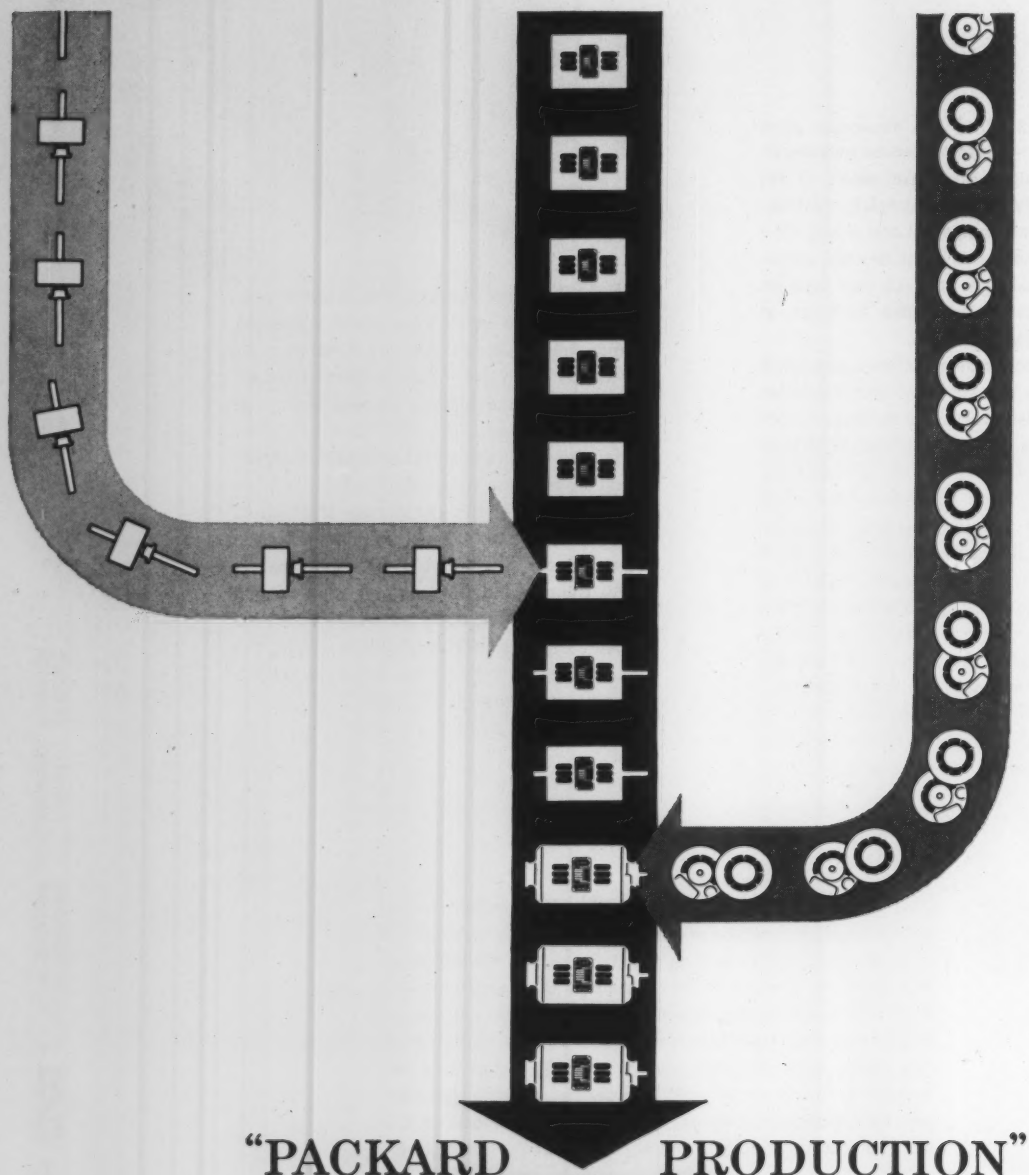
USS MAN-TEN High-Strength Steel Manufacturers have turned to high-strength steels to increase the strength of earthmovers without adding to their weight. LeTourneau-Westinghouse Company built their Model B scraper with USS MAN-TEN Low-Alloy High-Strength Steel in the yoke structure, side sheets, body truss tubes, and apron arms. MAN-TEN steel has a yield point of 50,000 psi—about 50% higher than carbon steel. This extra strength also permits designs with thinner, lighter sections that can reduce weight as much as 1/3 with no loss of strength. And though MAN-TEN steel is exceptionally strong, it is not difficult to form. In fact, MAN-TEN steel frequently simplifies fabrication because it can be used in lighter gages.

USS, MAN-TEN, and "T-1" are registered trademarks

STEELS FOR DESIGN

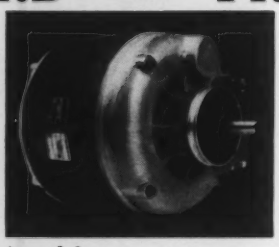
United States Steel USS

Please direct inquiries to advertiser, mentioning MACHINE DESIGN



"PACKARD PRODUCTION"

From raw materials to finished product, Packard Electric makes practically all its electric motor components. Starting with copper and aluminum ingots and steel from local mills "Packard production" features



controlled quality and on-time deliveries. These fractional horsepower motors, with the right switches, power cord and mountings—at the right cost—are the result of 40 years' experience in this specialized field.

fractional horsepower motors by

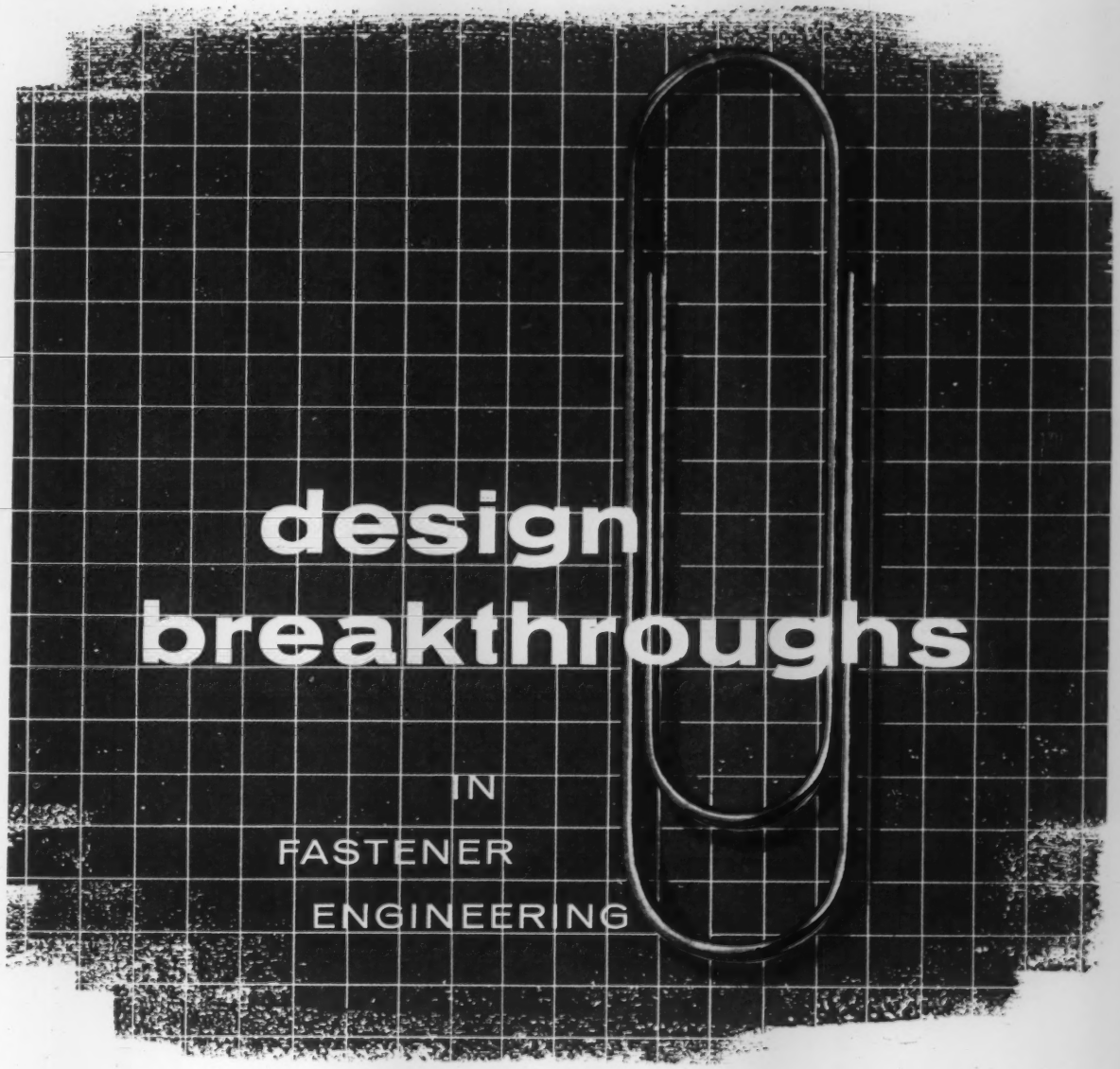
Packard Electric

Warren, Ohio

GM GENERAL MOTORS

Appliance Motor Specialists

Circle 446 on Page 19



An important breakthrough in fastener design a good many years ago was the common paper clip. And, although DOT is not a manufacturer of paper clips, many a DOT industrial fastener has had an equally revolutionary effect on modern fastening technique. Hundreds of different DOT fasteners have created relatively minor revolutions in specific industries.

A DOT fastener may save a few man-minutes of labor. It may save material. Or it may improve product performance and hence saleability. But multiply each small improvement by the units in a true mass-production operation and the savings really pile up to impressive proportions.

Rather than spend your own design staff's time on fastening problems, it might pay you well to call in DOT. You'll have at your service a design and production organization with large-scale facilities for genuine mass-production of special-purpose fasteners and self-fastening devices of all kinds.

Supplementing the Carr Fastener Company are a number of other plants which form the United-Carr Fastener group. They are located in the principal production centers of the United States, Canada, England and Australia. Your nearest United-Carr field office (see below) is no further away than a telephone call from your desk.

MAKERS OF DOT FASTENERS

CARR FASTENER COMPANY

Division of UNITED-CARR Fastener Corp., Cambridge 42, Mass.

Offices In:

Atlanta, Boston, Chicago, Cleveland, Dallas, Detroit, Los Angeles, New York, Philadelphia, Syracuse

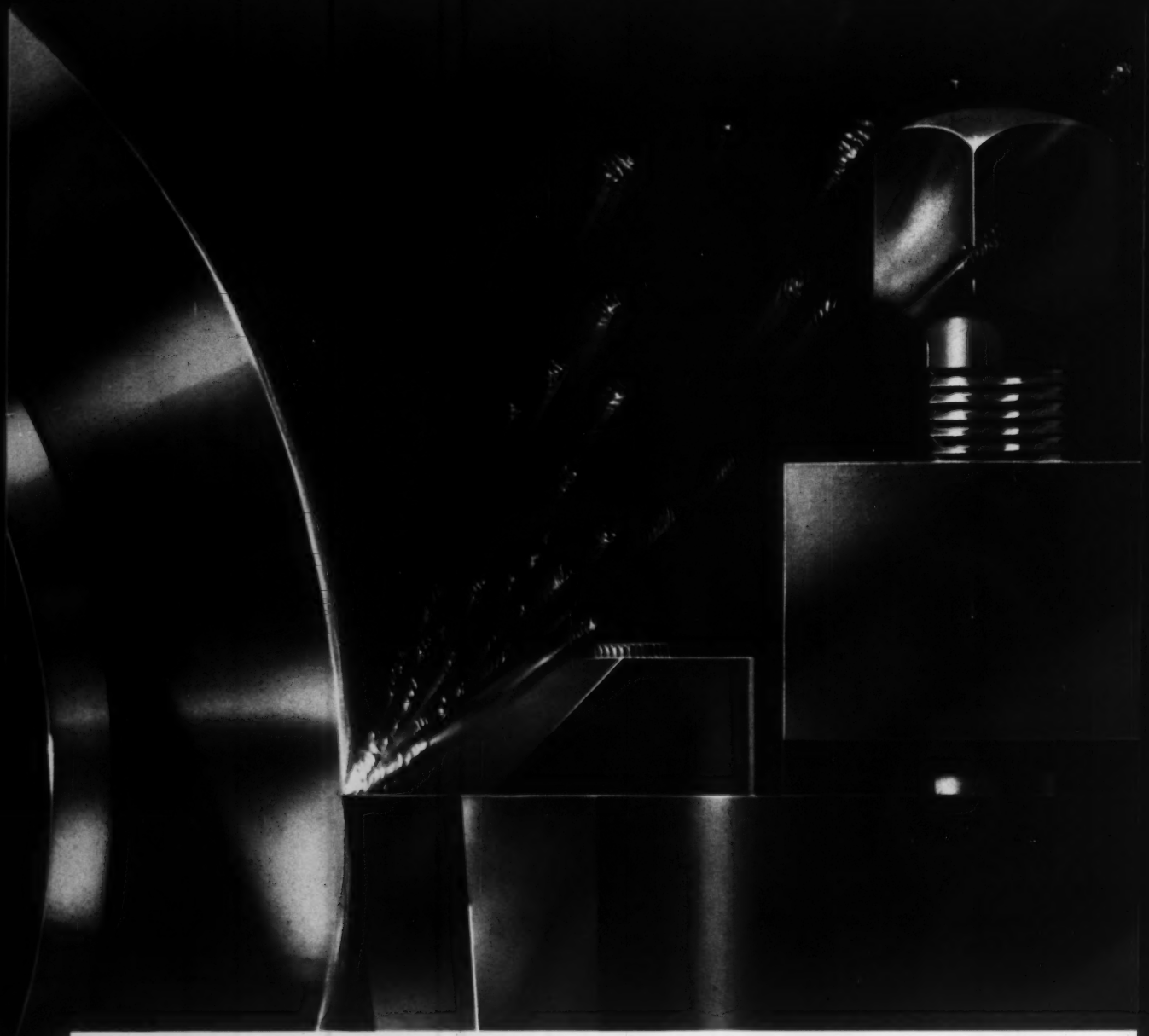


Illustration of Malleable casting being turned at 1,400 surface feet per minute with a 0.100" depth of cut using an oxide tool.

Machinability is Malleable

It's the finished cost of machined components that's important to you. Remember then . . . Malleable iron is more machinable than any other ferrous metal of similar properties. With Malleable castings you'll reduce machining time as much as 50% . . . increase tool life up to 250% . . . get unexcelled surface finishes . . . and end your reject problems.

To find out how much you can cut your costs and improve your profits, contact one of the progressive firms that displays this symbol—

MEMBER
MALLEABLE
CASTINGS COUNCIL

If you wish, you may inquire direct to the Malleable Castings Council, Union Commerce Building, Cleveland 14, Ohio, for information.

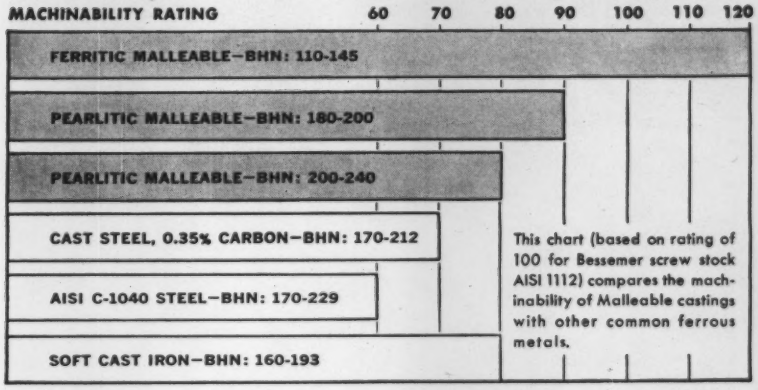
Machining Malleable Castings—Important Key to Cost Reduction

Malleable castings—the most machinable of all ferrous metals—cut quality components costs

Production men know that machining time, power consumption and rejects drop with the use of Malleable iron castings, while tool life and profits shoot up. The reason is simple: Malleable iron is the most machinable of all ferrous metals of similar properties.

The following important factors work together to give Malleable such machining superiority: Malleable's microstructure contains tiny, evenly distributed nodules of carbon that help cutting tools quickly break the removed metal into small (Class A) chips; the carbon also acts as a lubricant, prolonging tool life; uniformity of properties throughout every casting permits running at optimum machining conditions.

Comparison Shows Malleable's Superiority



Typical Example Shows Savings of 70% to 250%

The conversion of automotive universal joint yokes from steel forgings to pearlitic Malleable castings typifies the savings provided by Malleable castings. Costs for the rough pieces and performance characteristics of the two materials are comparable. However, the castings are much more economical to machine. Considering that machining often costs two to four times as much as the rough parts, the economy resulting from using Malleable castings is substantial.

Conversion of this universal joint yoke to a Malleable casting increased production, lowered direct and tool room labor, and cut tool replacement.

One volume user of Malleable joint yokes reports the following savings after changing from steel to Malleable castings: 70% longer tool life in broaching the splines; 250% more pieces cut by the nut seat cutters; 149% more pieces in turning and facing the hub; an increase of 100% in production between wheel dressings in grinding the hub; 246% greater production in drilling the cross holes.

In each of these operations, the change to Malleable castings cuts direct production time by reducing the frequency of tool changes. Tool room labor and tool replacement are both reduced to fractions of their previous costs.

Throughout the metalworking industry, part after part is now being initially designed of Malleable or converted from other materials to take advantage of Malleable's unrivalled machinability . . . to produce better parts at lower costs.

New Information Now Available on Machining Malleable

Data Unit 106—Machinability of Malleable Castings—can be obtained from any member of the Malleable Castings Council, or from the Malleable Castings Council, Union Commerce Building, Cleveland 14, Ohio.

These companies are members of the

MALLEABLE CASTINGS COUNCIL

CONNECTICUT
Connecticut Mall. Castings Co., New Haven 6
Eastern Malleable Iron Co., Naugatuck
New Haven Malleable Iron Co., New Haven 4

DELAWARE
Eastern Malleable Iron Co., Wilmington 99

ILLINOIS
Central Fdry. Div., Gen. Motors, Danville
Chicago Malleable Castings Co., Chicago 43
Moline Malleable Iron Co., St. Charles
National Mall. and Steel Castings Co., Cicero 50
Peoria Malleable Castings Co., Peoria 1
Wagner Castings Company, Decatur

INDIANA
Link-Belt Company, Indianapolis 6
Muncie Malleable Foundry Co., Muncie
National Mall. & Steel Castings Co., Indianapolis 22
Terre Haute Mall. & Mfg. Corp., Terre Haute

MASSACHUSETTS
Belcher Malleable Iron Co., Easton

MICHIGAN
Albion Malleable Iron Co., Albion
Auto Specialties Mfg. Co., Saint Joseph
Cadillac Malleable Iron Co., Cadillac
Central Fdry. Div., Gen. Motors, Saginaw

MINNESOTA
Northern Malleable Iron Co., St. Paul 6

NEW HAMPSHIRE
Laconia Malleable Iron Co., Laconia

NEW JERSEY
Meeker Foundry Company, Newark 4

NEW YORK
Acme Steel & Mall. Iron Works, Buffalo 7
Frazer & Jones Company Division Eastern Malleable Iron Co., Solvay
Oriskany Malleable Iron Co., Inc., Oriskany
Westmoreland Mall. Iron Co., Westmoreland

OHIO
American Malleable Castings Co., Marion
Canton Malleable Iron Co., Canton 5
Central Fdry. Div., Gen. Motors, Defiance
Dayton Mall. Iron Co., Ironton Div., Ironton
Dayton Mall. Iron Co., Ohio Mall. Div., Columbus 16
Maumee Malleable Castings Co., Toledo 5
National Mall. and Steel Castings Co., Cleveland 6

PENNSYLVANIA
Buck Iron Company, Inc., Philadelphia 22
Erie Malleable Iron Co., Erie
Lancaster Malleable Castings Co., Lancaster
Lehigh Foundries Company, Easton
Meadville Malleable Iron Co., Meadville
Pennsylvania Malleable Iron Corp., Lancaster

TEXAS
Texas Foundries, Inc., Lufkin

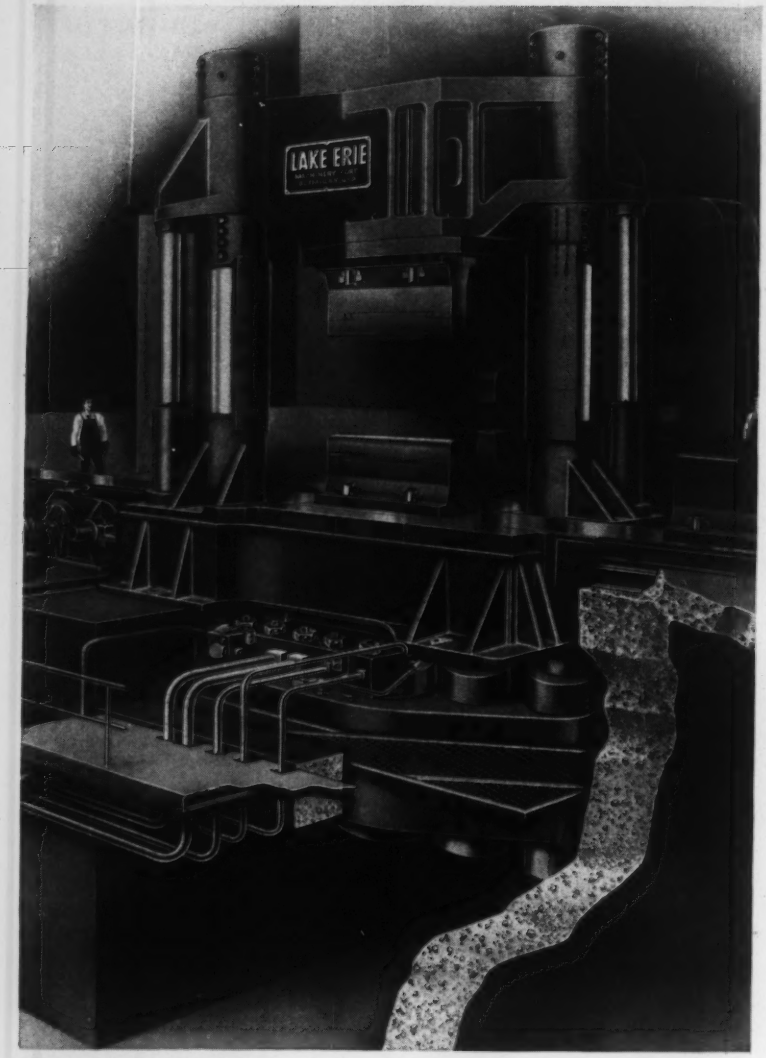
WEST VIRGINIA
West Virginia Mall. Iron Co., Point Pleasant

WISCONSIN
Belle City Malleable Iron Co., Racine
Chain Belt Company, Milwaukee 1
Federal Malleable Company Inc., West Allis 14
Kirsh Foundry Inc., Beaver Dam
Lakeside Malleable Castings Co., Racine
Milwaukee Malleable & Grey Iron Works, Milwaukee 46

Circle 448 on Page 19

How **DENISON HYDRAULICS** serves the **PRESS INDUSTRY**

5,000 psi **DENISON** hydraulic system supplies dependable power for **LAKE ERIE** 2,000-ton press



2,000-TON *high-speed forging press built by Lake Erie Machinery Corporation of Buffalo, New York. Stands 19 feet above floor level, extends 15 feet below floor level. Maximum working stroke is 72" with 120" maximum daylight.*

Powered hydraulically by twenty 5,000 psi Denison axial piston pumps, this 2,000-ton press is capable of 30 forging strokes-per-minute at full tonnage, 80 planishing strokes-per-minute at 1,000 tons. One of the largest, this single-action press of 2-column pull-down design is also one of the most efficient, self-contained hydraulic forging presses ever built.

The twenty Denison pumps, each having a capacity of 35.0 gpm, are driven by ten double-end, 150 horsepower, 1,200 rpm electric motors.

The pumping unit supplies pressure directly to the forging press cylinder, through the required valving.

Whatever your power needs, the Denison hydraulic specialist near you will analyze your requirements and suggest the most dependable and economical approach to your problem. Call him.

HYDRAULIC *power unit of 20 Denison axial piston pumps supplies hydraulic power to pressurized prefill tank mounted near press.*

DENISON ENGINEERING DIVISION
American Brake Shoe Co.
1240 Dublin Road • Columbus 16, Ohio
Denison Stocking Branch Offices: LOS ANGELES • CHICAGO
DETROIT • ATLANTA • HOUSTON • NEWARK • CLEVELAND

Denison and Denison HydrOILics are registered trademarks of Denison Eng. Div., ABSCO

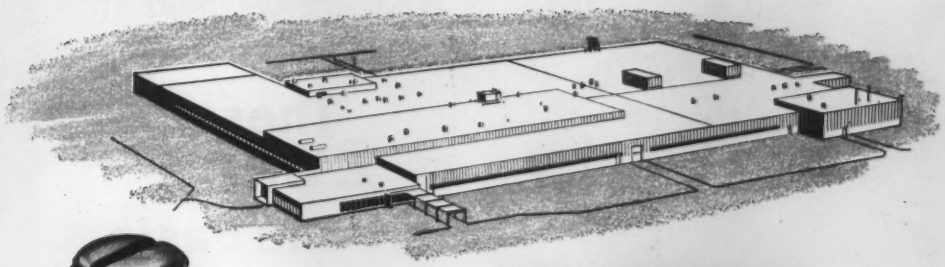
DENISON HydrOILics

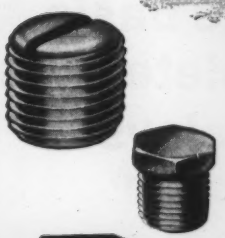
HYDRAULIC PRESSES • PUMPS • MOTORS • CONTROLS

Circle 449 on Page 19

NEW PLANT

You are cordially invited to visit us in our new factory — 242,000 sq. ft. of busy and well-organized manufacturing capacity.





ELCO

PIPE PLUGS

For many years we have been manufacturing quality Pipe Plugs in a wide variety of types, sizes, and materials. Using the cold-headed process exclusively — which is the world's best for maximum strength, maximum accuracy, controlled uniformity, and reliable product performance — we can fill your order for a thousand or a million promptly. All Elco Pipe Plugs feature the DRY-SEAL thread design which, in a mating tapped hole, eliminates the need for pipe compound — a tremendous time-saver to users. *For details, ask your Elco representative, or . . .*

Write for Full Information

ELCO SCREW CORPORATION

1910 SAMUELSON ROAD, ROCKFORD, ILLINOIS

Smaller Control Panels with

CLASS 8501
TYPE DO-22

These 2 UNITS are the basis for a Complete System of relays

CLASS 9050
TYPE AO-1E

Here's why designers and users alike prefer Square D...

Complete selection • Relays available for both AC and DC systems—with up to 10 contacts—in both electrically and mechanically held forms. Timing relays with intervals from 0.2 second to 3.0 minutes—also in AC and DC versions.

Require less panel space • Relays are only 3" wide, range in height from 3¼" to 5". Timers are just 2⅝" x 4⅜" or 2½" x 7²½". Mechanically held relays require no extra panel space.

No mounting problems • All Type D relays and Type A timers have identical mounting hole dimensions.

Easy wiring • Choose either pressure wire connectors or slip-on connectors for all terminals.

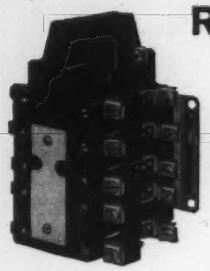
Long life • Balanced construction reduces wear on single moving part. Epoxy-resin molded coil operates cooler, virtually eliminates coil burnout.

D

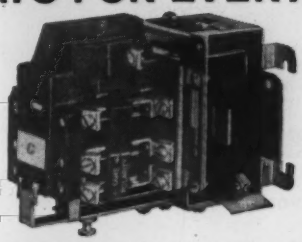
SQUARE D COMPANY

Square D "SYSTEM-DESIGNED" Relays

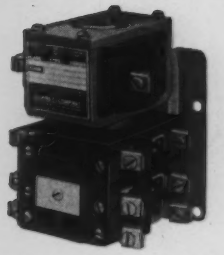
RELAYS FOR EVERY JOB



Square D Type D relays available with up to 10 contacts

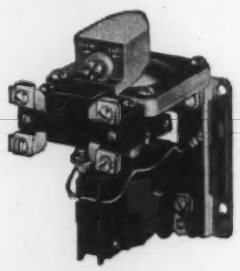


Easy-to-use attachment converts any Type D relay to mechanically held with no increase in panel space

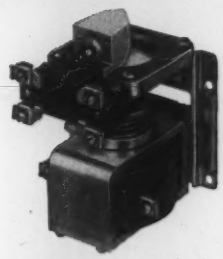


DC relays have mounting dimensions and contact arrangements identical to AC relays

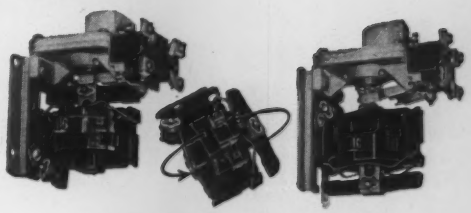
WIDE CHOICE OF TIMERS



Timing relays have same mounting dimensions as Type D relays

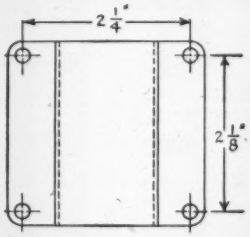


Matching DC timing relays

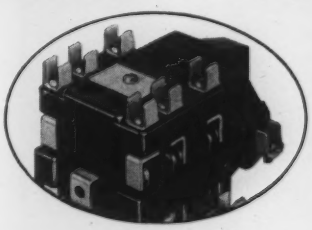


Both AC and DC versions convertible from on-delay to off-delay, using only a screwdriver

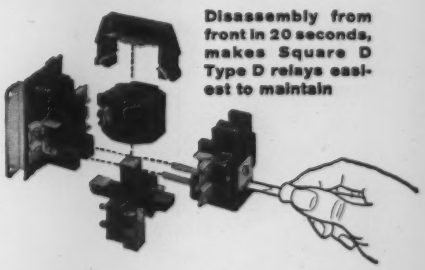
FAMILY FEATURES SIMPLIFY DESIGN PROBLEMS



Mounting dimensions are identical for Type A timers and Type D relays



Slip-on connectors for all terminals available



Disassembly from front in 20 seconds, makes Square D Type D relays easiest to maintain

Write for full details • Ask for Bulletin D, Square D Company, 4041 N. Richards St., Milwaukee 12, Wis.

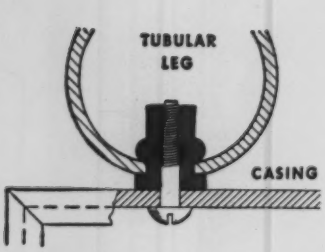
Square D offers the broadest line of relays, starters and accessories for all types of control systems

Ask your Square D Field Engineer about the new ILO program

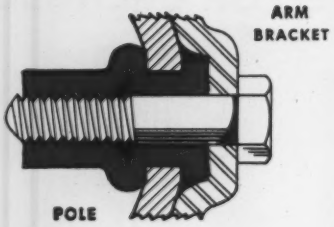
Circle 451 on Page 19

B.F.Goodrich

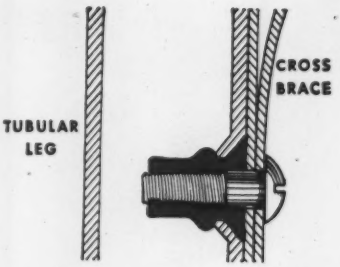
Only B.F.Goodrich Rivnuts® solve all these fastening problems so well



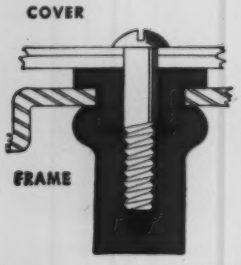
One man installs Rivnuts from one side in seconds—speeds assembly of *barbecues*. Permanent nutplates in legs save time in faster knockdown, too.



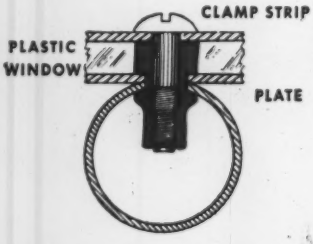
One man does the work of two, assembling arm brackets on *light poles*. Tests show pole or arm will fail before Rivnuts.



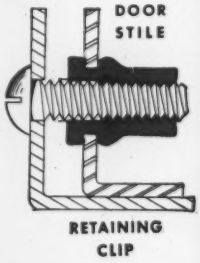
Clean, functional lines of modern *furniture* are preserved by Rivnuts. Upset inside tubular legs, they replace unsightly nuts, bolts and screws.



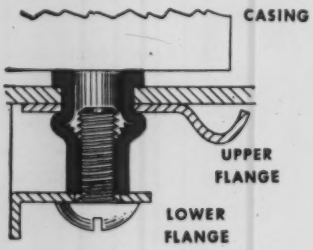
Rivnuts enable repair men to remove top of *automatic washer* and replace it easily. And Rivnuts can be installed after enamelling.



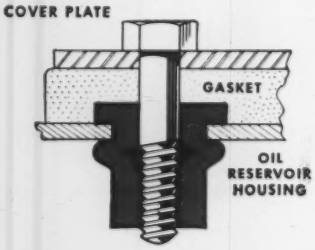
Upset Rivnuts secure *airplane window* plate to center post. Bulges in shanks seal out weather. Heads of Rivnuts serve as spacers for plastic window.



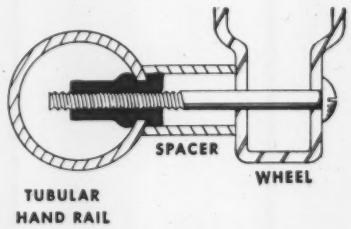
Rivnuts replace self-tapping screws used to hold retaining clips on aluminum *storm doors*, provide firm nutplates that won't loosen with shock or vibration.



Rivnuts eliminate need for reinforcing plates in *vaporizers*. In addition, Rivnuts space bottom flange automatically, prevent bending.



Assembly time for *oil reservoirs* is cut in half. Rivnuts eliminate welding, tapping and cleaning previously required to attach coverplate.



Wheel chair designers needed a blind nutplate with at least 6 clean threads. Rivnuts, only one-piece blind rivets with threads, were the answer.

Special fastening problems? B.F.Goodrich Rivnuts solve them. Send for free data book. Dept. MD-119, B.F.Goodrich Aviation Products, a division of The B.F.Goodrich Company, Akron, Ohio.

B.F.Goodrich *aviation products*

J. F. HARPER, OF HARPER
BUFFING MACHINE COMPANY, SAYS . . .

"General Electric Motor *Econo-matching** Saved Me Over $1300 Per Machine!"

***GENERAL ELECTRIC ECONO-MATCHING** is the quick and accurate matching of Tri-Clad '55' a-c motors to machines by skilled G-E engineers.

ECONO-MATCHING recently helped increase equipment efficiency and reduce unit costs at Harper Buffing Machine Company, East Hampton, Connecticut.

After selecting a drive to power his new "Harperizer†" free-grain buffing machine, J. F. Harper (above center) called his G-E Distributor, who in turn arranged for a team of General Electric Econo-matching engineers to study its drive requirements at no cost to Mr. Harper!

"G-E ENGINEERS STUDIED OUR APPLICATION," said Mr. Harper, "and advised that we could get maximum efficiency and economy by replacing the drive we had selected with a Tri-Clad '55' 50-hp open drip-proof motor. We did, and realized an immediate savings of over $1300 per unit!"

MORE THAN THREE BILLION integral-hp a-c motor types are available to the G-E engineers who can select the drive to meet your needs. Let them help you get the most from your equipment investment!

†Trademark of Harper Buffing Machine Co.

GENERAL ELECTRIC

RETURN THIS COUPON . . .
for more Econo-matching details, or call your nearby General Electric Apparatus Sales Office for complete information on how G.E. can ECONO-MATCH a motor to meet your specific requirements.

Circle 453 on Page 19

Section A891-22A
General Electric Company
Schenectady, New York

Please furnish more information on how you can ECONO-MATCH a motor for my application, which is_____

NAME_____ TITLE_____

COMPANY_____

CITY, STATE_____

SALT WATER CORROSION

How Lukens *Application Research* can help you find the right steel plate for the job

Among other materials, our Application Engineering staff has studied the outstanding nickel alloy, Monel, in a variety of salt water applications. Monel is surprisingly economical when used in clad plate form—a Lukens specialty produced by bonding a layer of Monel to a tough, low-cost carbon steel backing plate.

The massive legs of off-shore radar platforms, for example, are protected by Lukens Monel-clad steel plate. Our engineers recommended this shielding for the critical splash areas extending above and below the water line. It has proved a most successful application.

Salt water swimming pools on ocean liners, traditionally of tile, often require extensive repair between voyages. We helped solve this problem for a well-known steamship line—again with Monel-clad steel plate. Beautiful to look at, these sea-going pools need only routine cleaning and maintenance. Many are now in service—others are being built, including one for the nuclear powered *Savannah*.

If your assignment is salt water corrosion, let it be our assignment, too. Lukens Application Engineers have documented cases covering a wide range of materials selection problems—to help you choose the right steel plate.

Contact Manager, Application Engineering, E119 Services Building, Lukens Steel Company, Coatesville, Pa.

Helping Industry Choose Steels That Fit The Job

LUKENS

ASK FOR THE BULLETIN ON LUKENS CLAD STEELS

SPICER RUBBER ELEMENT SHAFTS CAN HELP YOU SOLVE YOUR TORSIONAL RESONANCE PROBLEMS

If you are faced with the problem of torsional vibration from impulses within the operating range, Dana engineers may be able to help you solve your design problems.

Spicer resilient propeller shaft assemblies have been used successfully for years in rapid transit cars, street cars, engine dynamometer, truck, bus, earthmover and passenger car applications to solve difficult torsional problems.

Spicer rubber-cushioned shafts make it possible for design engineers to "tune out" the vibration and thus produce commercially acceptable installations.

Spicer rubber-cushioned propeller shafts offer these additional advantages:

1. The torsional flexibility limits the effect of high impact loads resulting from rough shifts and other sudden torque changes.
2. The cushioning effect prevents clatter, rattle, and backlash noises.
3. Increased life of bearings, gear teeth, splines, and other components due to the reduction of high impact and torsional loads.
4. Reduction of noise transfer.
5. Axial flexibility to cushion forces resulting from length changes.

Product knowledge and years of experience are available to you through Dana engineers to help solve your torsional problems. Contact them today.

International 295 Payscraper, equipped with a Spicer rubber element shaft, at work on the Interstate Highway System

DANA Spicer

DANA CORPORATION

Toledo 1, Ohio

SERVING TRANSPORTATION—Transmissions
Auxiliaries • Universal Joints • Clutches • Propeller Shafts • Power Take-Offs • Torque Converters Powr-Lok Differentials • Gear Boxes • Forgings Axles • Stampings • Frames • Railway Drives

Many of these products are manufactured in Canada by Hayes Steel Products Limited, Merritton, Ontario

Circle 455 on Page 19

Are you shock-proof?

Ever sit in a traffic-trapped taxi for an hour . . . only to find your destination was just around the corner? Ever build a patio . . . only to find a contractor would have done it for less than the cost of your materials? Ever sweat six months over a problem on the job . . . only to find the solution had been available by picking up the phone?

Carpenter can't shock-proof you from everything, but we *can* help you with the application of electronic, magnetic and electrical alloys. No matter how difficult your problem, there's an excellent chance that our continuing research and development program has already produced information to save you time and money.

In addition to leading the field in technical assistance to industry, *Carpenter* also provides the convenience and reliability of one-source supply. You name it—dimensional control, resistance control, magnetic control—*Carpenter* offers the world's widest range of alloys to meet your most critical needs.

Carpenter alloys provide easy, fast fabrication, such as blanking, edge-winding, spot-welding and machining. And you waste no time experimenting to find the proper heat treating methods and temperatures. Highly specialized as these alloys are, *Carpenter* has "standardized" their properties to minimize problems from design to delivery.

Why not check *Carpenter now* . . . instead of later?

Carpenter **steel**

tool and die steels
stainless steels
electronic, magnetic and electrical alloys
high temperature alloys
special-purpose steels
tubing and pipe
fine wire specialties

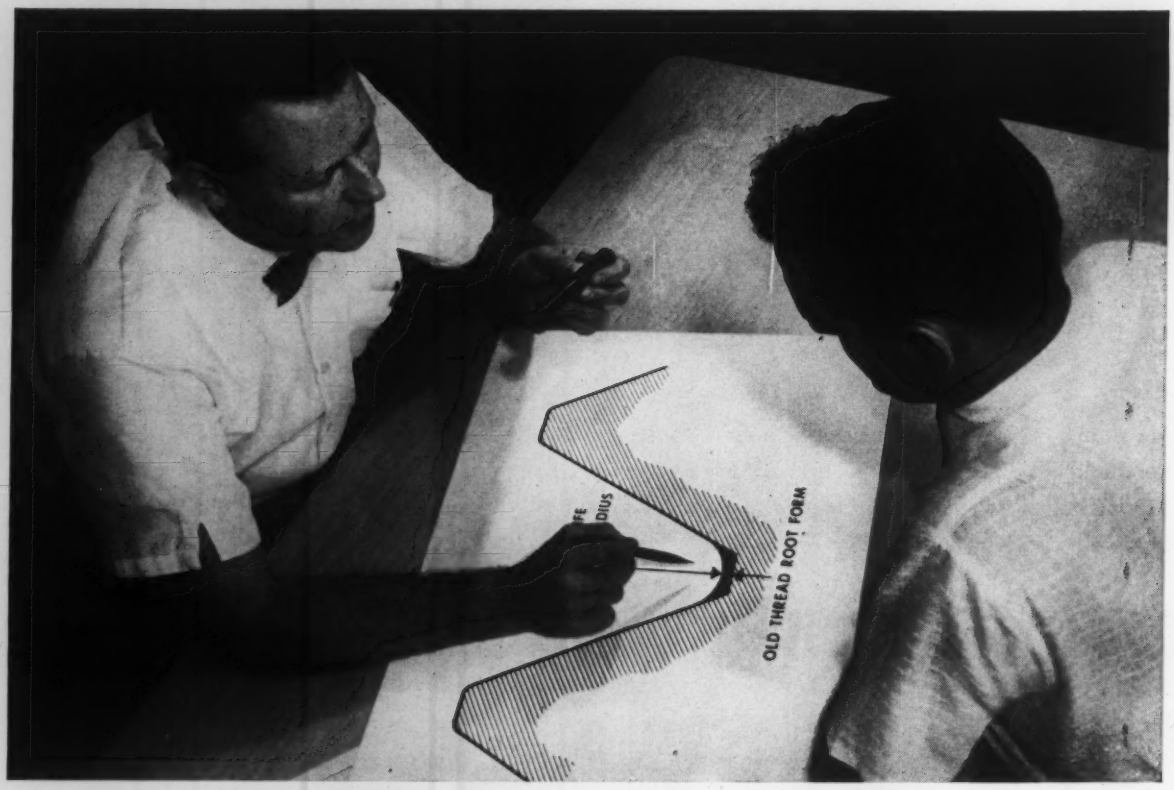
A Talley Company — 70 years old

The Carpenter Steel Company, Main Office and Mills, Reading, Pa.
Alloy Tube Division, Union, N. J.
Webb Wire Division, New Brunswick, N. J.
Carpenter Steel of New England, Inc., Bridgeport, Conn.

Circle 456 on Page 19

SPS RELIABILITY / *A dynamic standard of predictable performance*

The big change is in the threads



Extra strength for screw-fastened assemblies. New UNBRAKO Hi-Life thread form developed by SPS research features smoothly radiused contour, with more metal at root. New profile virtually doubles fatigue life, adds tensile strength. Hi-Life screws fit standard tapped holes, cost no more than former UNBRAKOs.

New thread form on UNBRAKO Hi-Life cap screws increases fatigue life up to 100% . . . gives your product added reliability at no extra cost.

For years the conventional thread root form for socket screws has been a truncated V with flat root. In the new UNBRAKO Hi-Life screws this is changed, the root being smoothly radiused from flank to flank. The result? A major reduction in stress concentrations at this critical point.

In terms of fastener performance, tests show the new UNBRAKO Hi-Life socket head cap screw gives you up to 100% more fatigue life than flat root screws. And you also get a bonus in tensile strength, because UNBRAKO Hi-Life has more metal at its minimum cross section. Both benefits are achieved without effect on gaging or ease of engagement.

New Hi-Life UNBRAKOs give your product added insurance against failures caused by dynamic stresses—particularly under field conditions where screws may not always be seated or tightened properly. And on the assembly line, their greater tensile strength permits higher preloading, which lengthens fastener fatigue life.

Your authorized SPS distributor has new UNBRAKO Hi-Life socket screws in stock now in sizes #4 through 1½ inch. See him for details, or write SPS—manufacturer of precision threaded industrial fasteners and allied products in many metals, including titanium. Request new Bulletin 2577.

TENSION-TENSION FATIGUE TESTS

½-20 Socket Head Cap Screws

Testing Speed: 1050 CPM	Average Fatigue Cycle Life	
Alternating Stress (psi)	Old Thread Root Form	UNBRAKO Hi-Life Thread
7,000 to 70,000	22,900	40,000
5,000 to 50,000	56,650	89,950
4,000 to 40,000	120,700	232,350
3,000 to 30,000	598,000	1,808,000
2,000 to 20,000	2,076,000	8,000,000*

*Test stopped—no failure

Tests run on ½-20 Hi-Life socket head cap screws show an increase of up to 100% in fatigue life over old-style screws with flat root. Radiused root of UNBRAKO Hi-Life thread reduces stress concentration at point where majority of fatigue breaks occur.

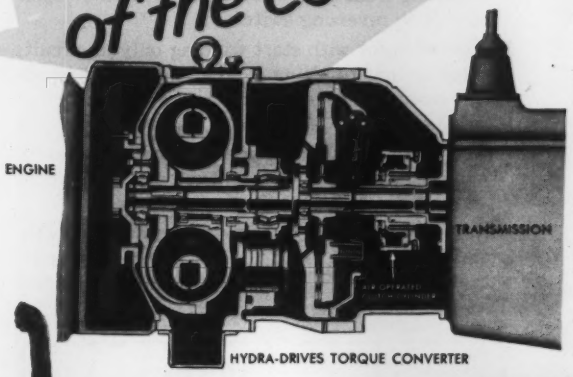
INDUSTRIAL FASTENER Division SPS

JENKINTOWN 18, PENNSYLVANIA

HYDRA-DRIVES®

TORQUE CONVERTER WITH A STICK SHIFT TRANSMISSION!

Now! Many Of The Advantages Of Power Shift Transmission *at a fraction of the cost!*



HYDRA-DRIVES TORQUE CONVERTER

Lower in initial costs, Rockwell-Standard's Hydra-Drives Converter with stick shift transmission reduces operating and maintenance costs on heavy-duty off-highway trucks. You get these five major advantages plus many others:

1. Up to 80% of shifting is eliminated. Select a transmission ratio to fit the haul, and let the converter handle the changing load conditions with a minimum of gearing. Any required shifting can be done while truck is in motion!
2. Greatly reduces shock loading on all drive components.
3. Clutch adjustments and wear problems minimized.
4. A minimum of driver training is required.
5. Cost is hundreds of dollars less than full power shift transmissions.

For further details write or call Rockwell-Standard Corporation

today!

ANOTHER PRODUCT OF **ROCKWELL-STANDARD** CORPORATION

Circle 458 on Page 19

No Other PROTECTOR but KLIXON Type T* Gives Your Product GREATER RELIABILITY

GREATER . . .

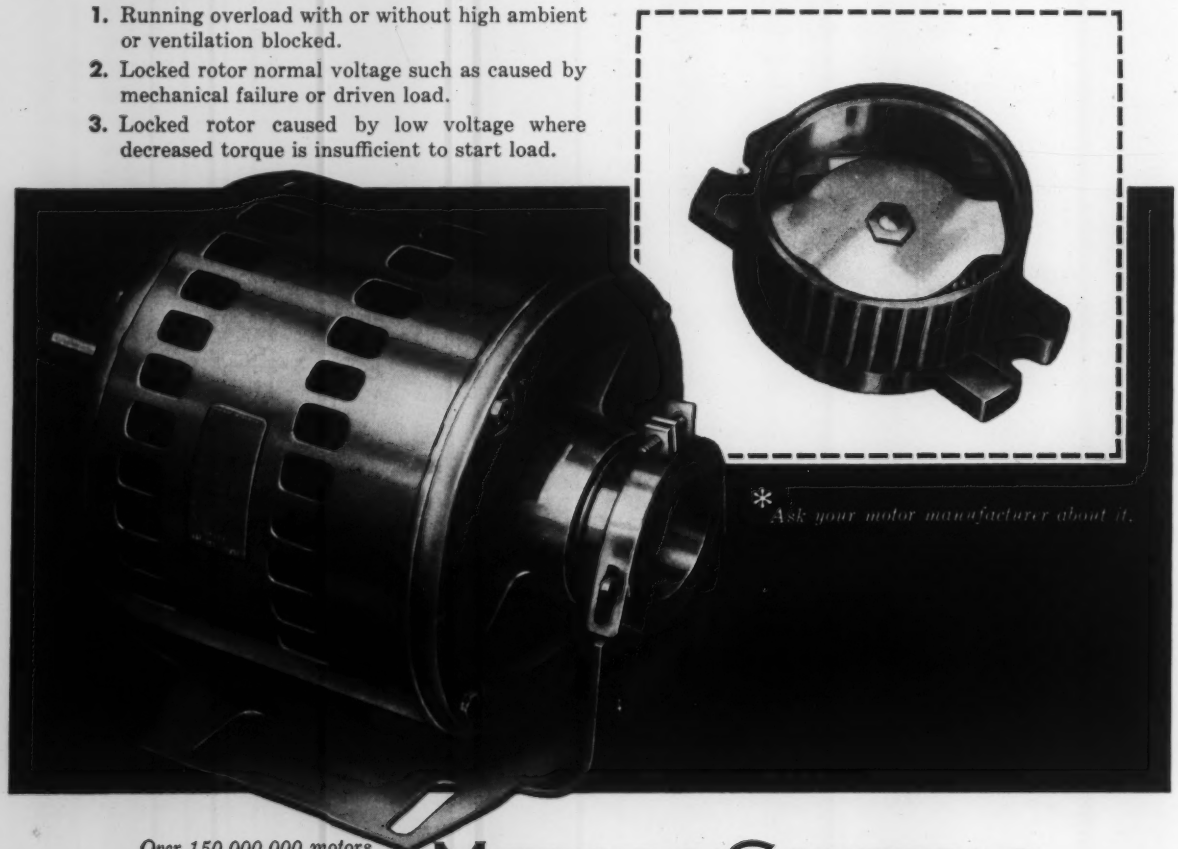
- ***Assurance Against Motor Failure***
- ***Reduction in Repairs and Service***
- ***Customer Satisfaction and Goodwill***

KLIXON and only KLIXON Type T Protectors completely safeguard motors against all possible conditions that cause motor burnouts.

Most conventional protectors used today provide only limited motor protection . . . against two, three or four overheat conditions. But KLIXON Type T Protectors safeguard motors from all six causes of motor burnout.

1. Running overload with or without high ambient or ventilation blocked.
2. Locked rotor normal voltage such as caused by mechanical failure or driven load.
3. Locked rotor caused by low voltage where decreased torque is insufficient to start load.
4. Locked rotor with main winding only in circuit resulting from open circuit start switch or open circuit in reversing switch.
5. Locked rotor with start winding only in circuit, such as that resulting from an open main winding circuit or open circuit in reversing switch.
6. Running with both start and main windings in the circuit resulting from start switch failure in closed position or low voltage which prevents reaching switchover speed.

Protect your motor-driven equipment completely against motor burnouts . . . specify on your purchase orders — "These Motors to have KLIXON Type T Protectors."



* *Ask your motor manufacturer about it.*

Over 150,000,000 motors are protected against overheating and burning out with KLIXON *Protectors.*

METALS & CONTROLS
3211 FOREST STREET, ATTLEBORO, MASS., U.S.A.
A DIVISION OF TEXAS INSTRUMENTS INCORPORATED

SPENCER PRODUCTS: Klixon® Inherent Overheat Motor Protectors • Motor Starting Relays • Thermostats • Precision Switches • Circuit Breakers

JET ENGINE SUPPRESSOR

WITHSTANDS SUPERSONIC SHOCK

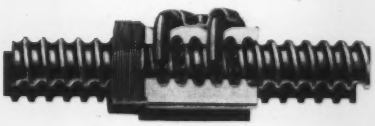
BUTTRESSED BY THE Saginaw b/b Screw

Suppressor in use behind an Air Force F-86 H "Sabrejet"

Muting the ear-shattering roar of a jet engine on pre-flight "run-ups" is the job of Koppers Company, Inc.'s new Portable Run-Up Suppressor. And four Saginaw Ball Bearing Screws—flanking the body of the Suppressor—help hold it rock-steady against the full force of the jet engine's supersonic blast!

These Saginaw b/b Screws enable the Suppressor to be hand-raised or lowered into position faster and with far less effort than by any other manual means. The reason? The Saginaw b/b Screw converts *rotary* motion into *linear* motion with over 90% *efficiency!* And the dependable Saginaw Screw also played a significant part in keeping the Suppressor both light in weight and portable in design.

Whether you manufacture miniature electronic controls or giant production equipment, the Saginaw b/b Screw may be able to give *your* products that valuable **S**ales **A**ppeal you're looking for. To discover all the benefits it can bring you, write or telephone Saginaw Steering Gear Division, General Motors Corporation, Saginaw, Michigan—*world's largest producers of b/b screws and splines.*



Give your products NEW SALES APPEAL... switch to the Saginaw

WORLD'S MOST EFFICIENT ACTUATION DEVICE

ball bearing Screw

Wherever your customers buy ALVANIA...

Its performance and name are the same around the world

Other Outstanding Shell Industrial Lubricants

Shell Tellus Oils—for hydraulic systems

Shell Talona R Oil 40—anti-wear crankcase oil for diesel locomotives

Shell Rimula Oils—for heavy-duty diesel engines

Shell Turbo Oils—for utility, industrial and marine turbines

Shell Dromus Oils—soluble cutting oils for high-production metal working

Shell Macoma Oils—for extreme pressure industrial gear lubrication

Shell Voluta Oils—for high-speed quenching with maximum stability

SHELL ALVANIA GREASE is available world-wide . . . assurance that your customers abroad will get the same performance from your equipment that domestic customers rely upon.

You can count on Alvania® Grease to remain plastic in sub-zero weather and, equally important, to remain stable under sustained high temperatures. On job after job, Shell Alvania Grease has successfully replaced dozens of special lubricants.

Alvania Grease also has an outstanding performance record on the toughest anti-friction bearing grease applications. It is ideal for wet, humid applications because it is inhibited to prevent water corrosion. It gives good lubrication under conditions which normally spell trouble.

For complete information on this truly multi-purpose grease, write Shell Oil Company, 50 West 50th Street, New York 20, New York, or 100 Bush Street, San Francisco, 6, California. In Canada: Shell Oil Company of Canada, Limited, 505 University Avenue, Toronto 2, Ontario.

SHELL ALVANIA GREASE

the truly multi-purpose lubricant

SHELL

Falcon missiles travel "first class" in containers secured by LINK-LOCK

Fourteen No. 2 LINK-LOCK fasteners → maintain a pressure-tight seal around cover of Falcon cases.

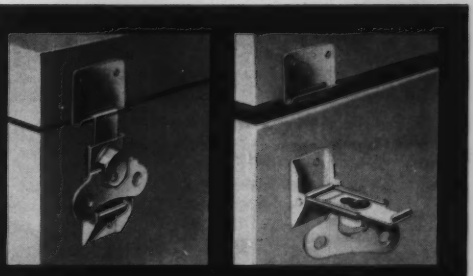
Before they take to the skies, Falcon air-to-air guided missiles are shipped or stored in containers sealed pressure-tight by Simmons LINK-LOCK fasteners.

These precisely engineered fabricated aluminum cases are produced to Hughes Aircraft Company specifications by the following companies: Vendorlator Manufacturing Co., Fresno, California; Allison Steel Manufacturing Co., Phoenix, Arizona; Avco Corporation, Crosley Division, Richmond, Indiana.

Features like these make the LINK-LOCK ideal for use on military cases made to rigid specifications as well as on inexpensive commercial containers:

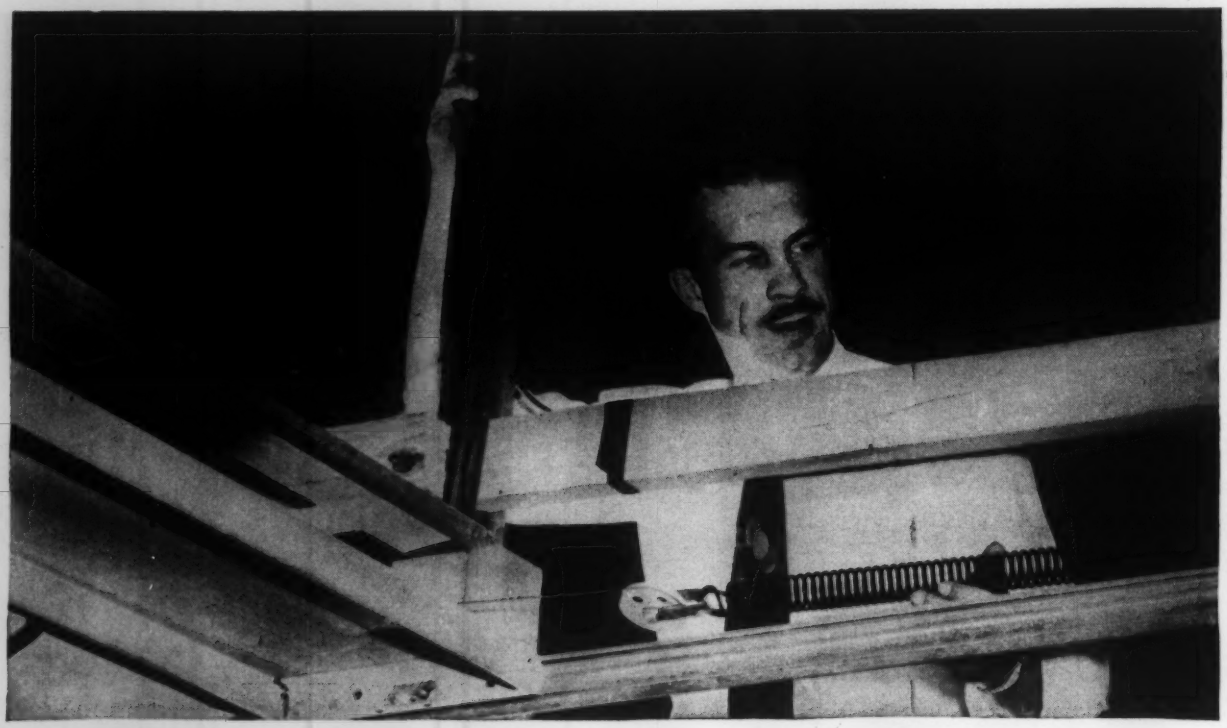
- Impact and drop resistant.
- Positive-locking without springs.
- High preloading and high load carrying capacity.
- Compact design—lies flat open or secured.
- 3 sizes, for heavy, medium, light duty.
- Flexible engagement latch design...can be varied to suit different applications.

Write for Catalog #1762. Contains complete details of LINK-LOCK and other Simmons Fasteners with unlimited money-saving applications. Samples and engineering service available on request.



Half-turn applies high closing pressure, counter-turn disengages for opening. LINK-LOCK lies flat open or closed.

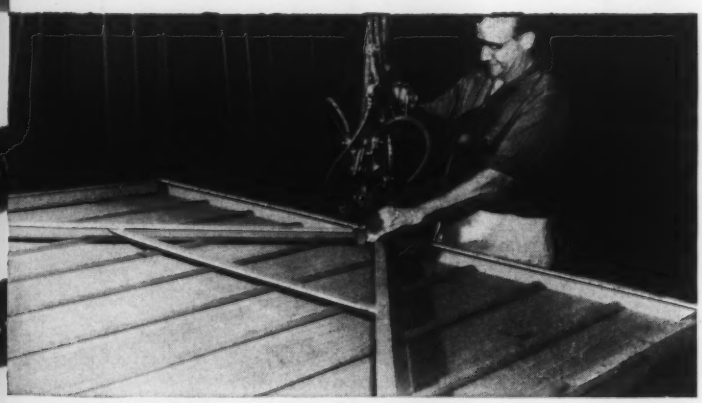
SIMMONS
FASTENER CORPORATION
North Broadway, Albany 1, New York
QUICK-LOCK • SPRING-LOCK • ROTO-LOCK • LINK-LOCK
DUAL-LOCK • HINGE-LOCK
See our 8-page catalog in Sweet's Product Design File



At Steel Door . . .

USS American Springs thanks to AS&W

In the American Steel & Wire Fatigue Laboratory, a technician runs tests on a USS American Spring, designed for Steel Door use. On the basis of this test a change in hook design was recommended to give longer spring life.



A Steel Door workman assembles a Berry One-Piece Door. This company uses steel exclusively for all doors because of its many consumer advantages. Steel is stable, won't warp or swell. Steel doors need less maintenance and preparation, and steel doors are easy to operate.

This close-up shows the improved hook on the extension springs supplied by American Steel & Wire for the Steel Door overhead garage doors.

stretched 31,000 times and still going strong...

Spring Engineering Research Service

The Steel Door Corporation, Birmingham, Michigan, is the world's largest manufacturer of residential garage doors. For the production of these doors they use about 150,000 USS American Springs every year. Steel Door asked American Steel & Wire for a statistical evaluation of the fatigue life of the extension hook-type springs they use. The AS&W Spring Engineering Research Service tested these springs in the Fatigue Laboratory and recommended a change in hook design.

So successful was this design change that the life of the springs has been materially increased. At the Steel Door plant a cycle test was set up using USS American Springs on an overhead door. At the present time these springs have completed over 31,000 cycles without showing any sign of failure. This is the equivalent of 25 years of normal usage.

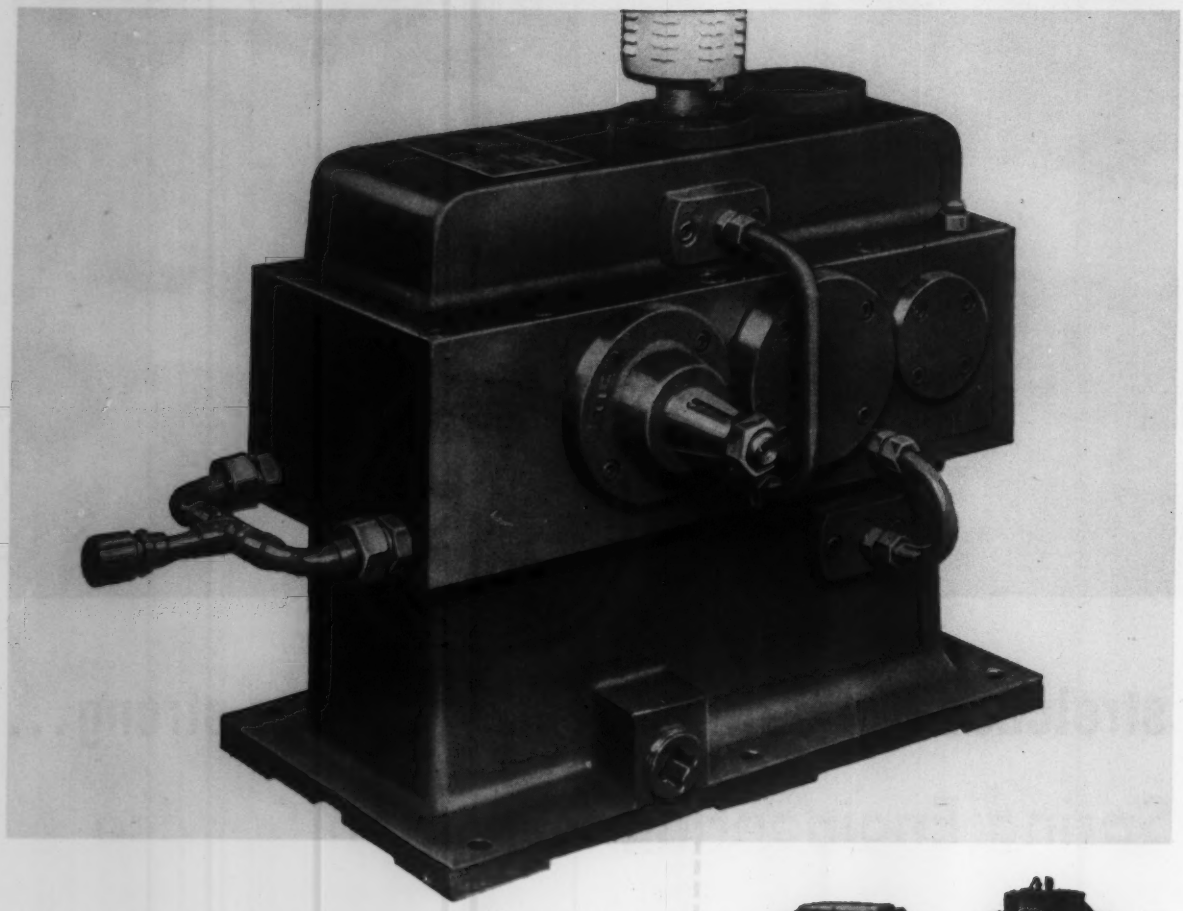
Mr. Ralph Qualman, Advertising Director and Service Manager, says: "It is extremely important that the springs—especially those used on sectional doors where the strain is greatest—have proper tension and a long life. American Steel & Wire supplies Steel Door with springs that meet their engineering specification and life expectancy."

If you have a spring problem or would like advice on the use of springs in your product, get in touch with our general offices in Cleveland, or any American Steel & Wire Sales Office. You can benefit from the knowledge of AS&W's Spring Engineering Research Service. The Service has been engaged in laboratory experiments of static and dynamic testing for 20 years and has accumulated invaluable data on stress and fatigue life of steel springs, while endeavoring to improve efficiency in the use of steel—from steel chemistry through product application—to more economically cope with today's rigorous demands. This accumulated knowledge of the AS&W Spring Engineering Research Service is at your disposal. *American Steel & Wire, 614 Superior Ave., N.W., Cleveland 13, Ohio.* *USS and American are trademarks*

American Steel & Wire Division of USS **United States Steel**

Columbia-Geneva Steel Division, San Francisco, Pacific Coast Distributors • Tennessee Coal & Iron Division, Fairfield, Ala., Southern Distributors • United States Steel Export Company, Distributors Abroad

100,000 RPM FOR A TEST STAND



Another example of Farrel's ability to meet extraordinary gearing requirements

The speed increaser shown above—built for operation at 100,000 rpm—is only one of the scores of highly specialized test-stand units designed and built by Farrel. Three other examples are shown at the right. Each was individually engineered to customer requirements.

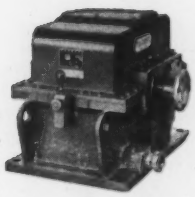
This experience offers virtual assurance of the ability to solve your high-speed gearing problems. The next time you need a test-stand unit, call Farrel. In the meantime send for a copy of bulletin 451.

FARREL-BIRMINGHAM COMPANY, INC.
ANSONIA, CONNECTICUT

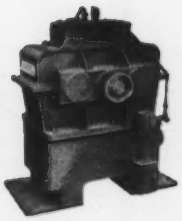
Plants: Ansonia and Derby, Conn., Buffalo and Rochester, N. Y.
Sales Offices: Ansonia, Buffalo, Akron, Ann Arbor (Mich.), Chicago, Minneapolis, Los Angeles, Salt Lake City, Tulsa, Houston, Atlanta
European Office: Piazza della Republica 32, Milano, Italy

FARREL

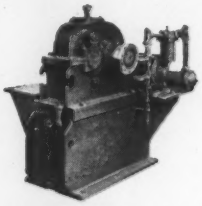
FB-1164



Special 375 HP speed-increasing unit, with two speed ranges, 6,000/10,769 RPM and 6,000/15,100 RPM.



Special DD-9 speed-increasing unit, 660 HP, input speed range from 1,500 to 3,000 RPM, output speed range from 20,000 to 40,000 RPM.



Special SI-825 speed-increasing unit, 150 HP, 3,000 to 5,000 input RPM, with 3 gear-set ratios—1:7.971, 1:2.5091, 1:1.0127.

Circle 463 on Page 19

Gallon and Quart bottles courtesy of Vanguard Plastics, Inc., Freehold, N. J.

O-o-o-o-o-p-s !

Thud! No crash, splatter, splash! But just plain thud! This bottle resists breakage because it's made of SUPER DYLAN® high density polyethylene. The gallon size weighs only 3½ ounces, yet it protects its contents . . . and the user, too! It's the bottle with the built-in bounce!

More than shatterproof, SUPER DYLAN bottles are rigid and light in weight—less than 1/10 the weight of gallon *glass* bottles. Needless to say, lightness like this cuts shipping expenses and simplifies handling.

Cost? Very economical. For sheer good looks you can just about name the color you want in SUPER DYLAN. Printability? It's easy by normal procedures.

SUPER DYLAN can be easily blow-molded into bottles of all sizes and shapes. You can use it to package almost anything. Acids, sure. Detergents, too; and cosmetics, pharmaceuticals, bulk chemicals, shampoos and food products. SUPER DYLAN resists heat and can be readily sterilized.

Write for more information on SUPER DYLAN high density polyethylene for bottles. Koppers Company, Inc., Plastics Division, Dept. MD-119, Pittsburgh 19, Pennsylvania.

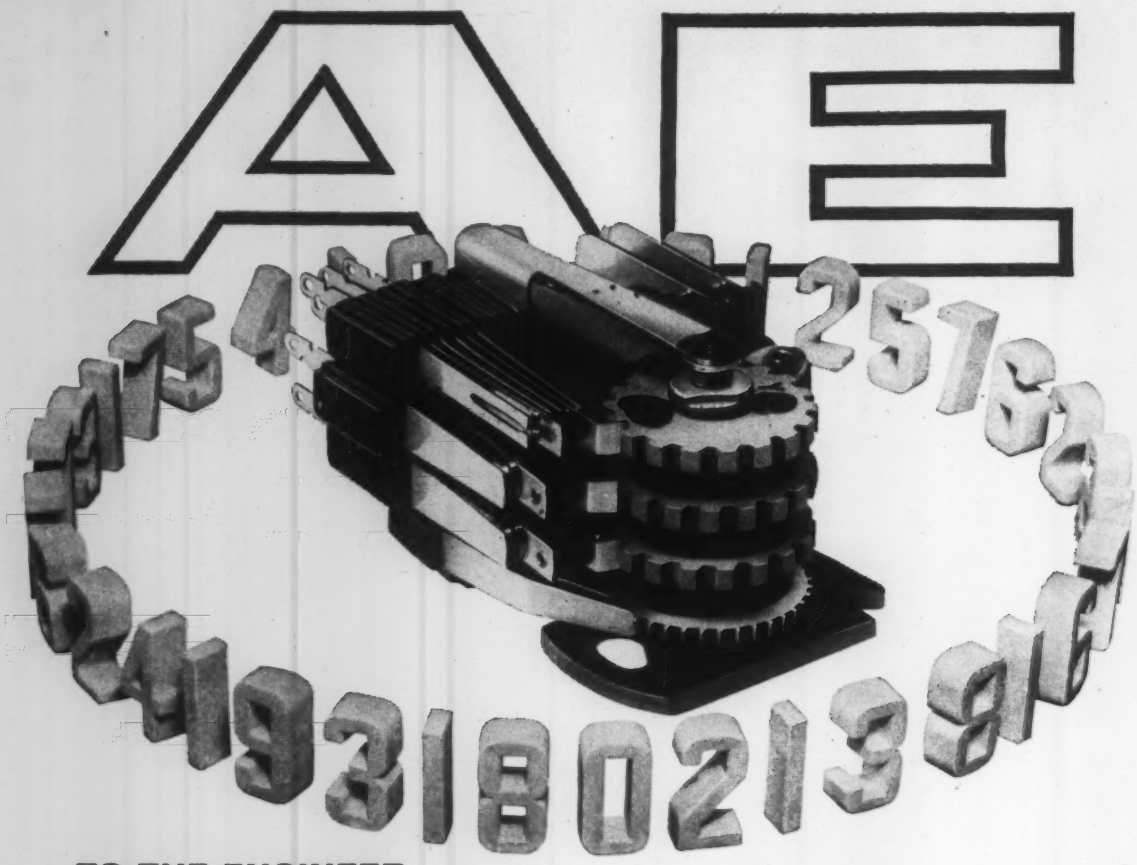
Offices in Principal Cities · In Canada: Dominion Anilines and Chemicals Ltd., Toronto, Ontario.

KOPPERS PLASTICS

DYLENE® polystyrene, DYLITE® expandable polystyrene, and DYLAN® polyethylene are other fine plastics produced by Koppers Company, Inc.

KOPPERS

Circle 464 on Page 19



TO THE ENGINEER

who can't tolerate a lapse of memory

If you're working on a think machine that can't afford to break its train of thought, consider AE's pint-size, fast-stepping OCS switcher. Unlike electron tubes and relays, this sophisticated device won't lose stored memory in the event of power failure or circuit interruption.

Besides, it can do the work normally assigned to whole banks of relays.

The AE Series OCS will follow or initiate a prescribed series of events or cycles at 30 steps per second impulse-controlled, or 65 steps per second self-interrupted. Any programming sequence can be set up on one to six cams with as many as 36 on-and-off steps per cam. And each cam will actuate as many as six contact springs.

In any event, if your designs involve relays or stepping switches, AE circuit engineers may be able to save you a pretty penny. Or, if you'd like to leave the switching to us, we're equipped to supply prewired and assembled, custom-built control units, *or* help you develop complete control systems.

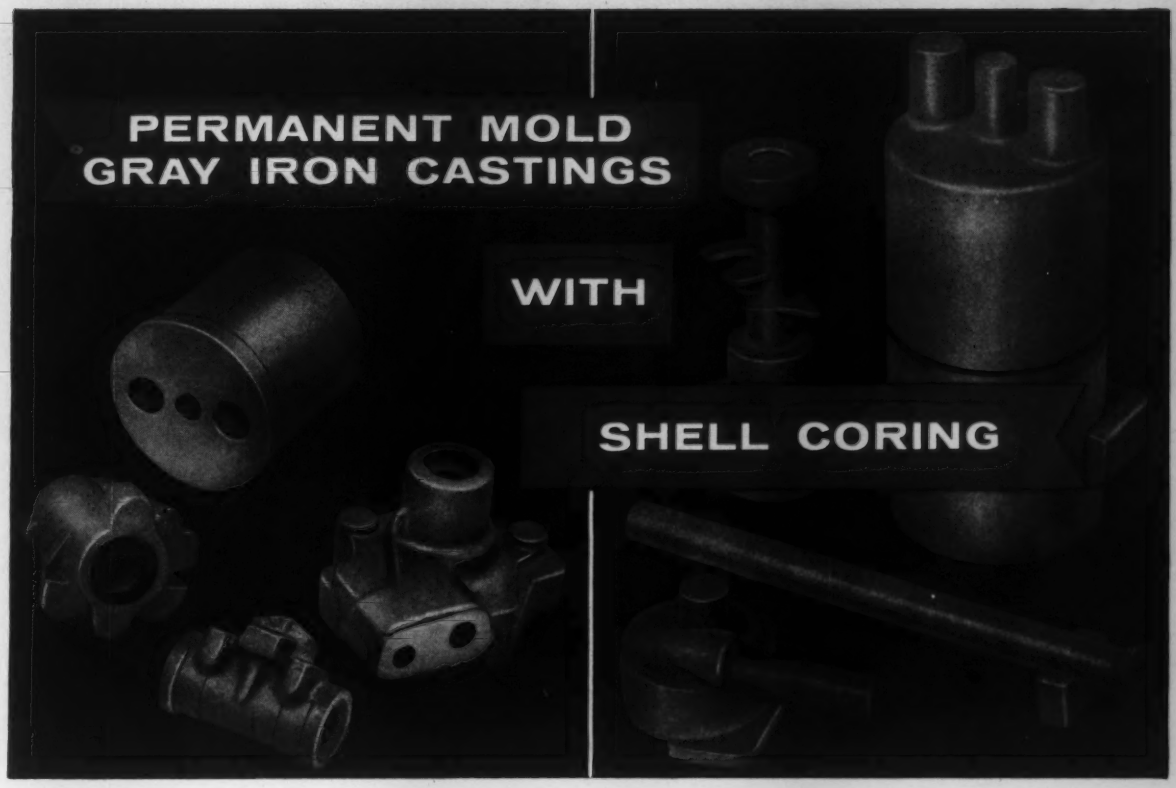
To explore the matter, just write the Director, Control Equipment Sales, Automatic Electric, Northlake, Illinois. Also ask for Circular 1698-H: *Rotary Stepping Switches;* Circular 1702-E: *Relays for Industry;* and our new 32-page booklet on *Basic Circuits.*

AUTOMATIC ELECTRIC GENERAL SYSTEM

Subsidiary of

GENERAL TELEPHONE & ELECTRONICS

Circle 465 on Page 19



RESULT: Better Finish at Lower Cost

In addition to the long recognized advantages of Eaton Permanent Mold Gray Iron Castings, the use of shell coring gives an even greater uniformity of structure and an improvement in internal surface finish. This results in machining economy and fewer rejections, which, in the end, mean lower cost of finished parts.

If you have applications where more than ordinary quality is required, Eaton Permanent Mold Gray Iron Castings offer many advantages. Whatever your requirements, our engineers will be happy to work with you.

Send for Illustrated Descriptive Literature

Consider these Important Advantages

- ★ Intricately cored sections
- ★ Uniformity of castings
- ★ Higher machining feeds and speeds
- ★ Substantially increased tool life
- ★ Dense, non-porous, homogeneous structure
- ★ Freedom from inclusions
- ★ Excellent tensile strength
- ★ Ability to take high surface finishes
- ★ Freedom from leakage under pressure

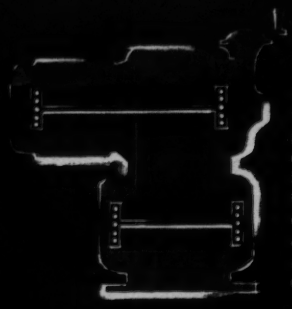
EATON

FOUNDRY DIVISION
MANUFACTURING COMPANY
VASSAR, MICHIGAN

Circle 466 on Page 19

Field Versatility

Mounting feet, end brackets, control hand wheel, conduit box, and output shaft can be relocated in minutes without special tools for wall, floor or ceiling mounting. Components can be changed or controls can be added in the field to meet ever changing conditions of operation.

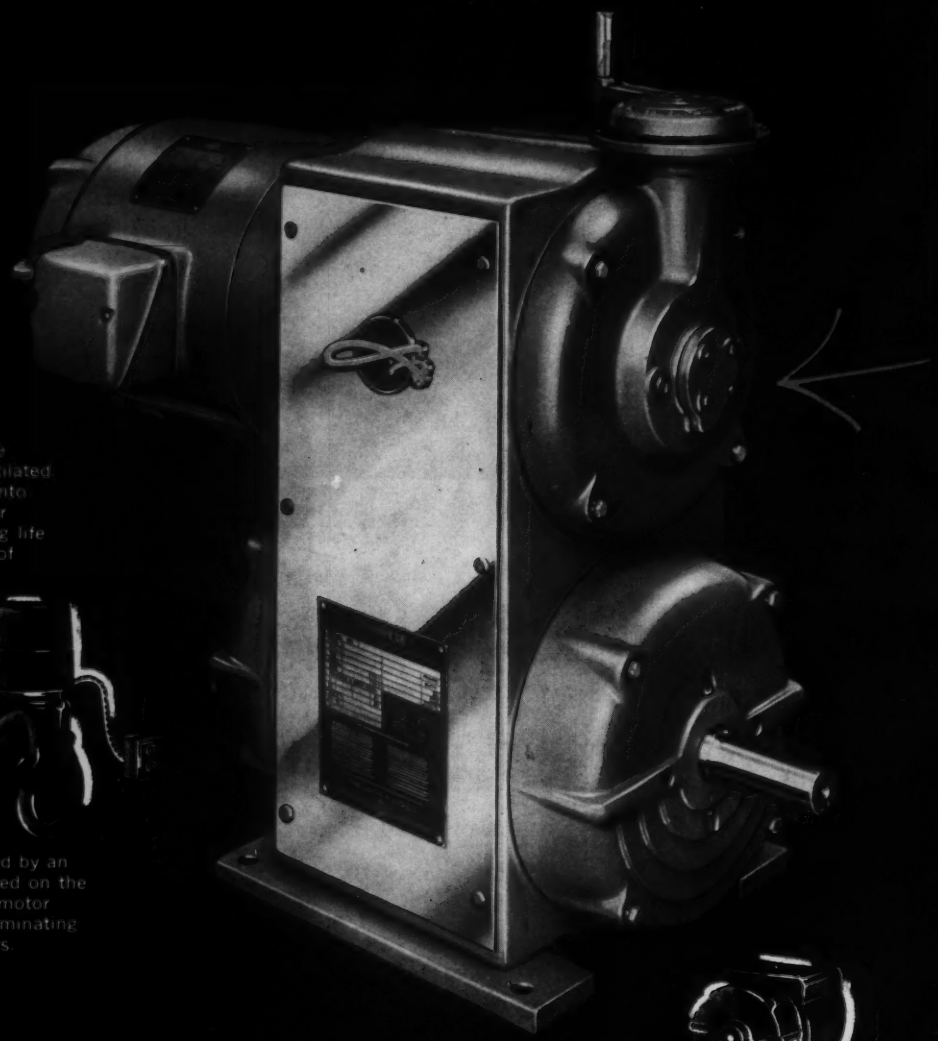


Four-Bearing Design

This important design feature eliminates the problems of overhung discs. It equalizes distribution of belt loading — keeps bearings, shafts, discs and belt permanently aligned — improves performance — and extends bearing life.

Dual-Ventilation System

The motor and the belt housing of the ALLISPEDE DRIVE are individually ventilated. Motor ventilating air is not exhausted into the belt housing — belts run cooler for longer life. Service factor and operating life of all components are higher because of lower operating temperatures.



Trouble-Free Remote Control

Electrical remote control can be provided by an enclosed speed adjusting motor, mounted on the belt changing mechanism. This torque motor can be stalled without overheating, eliminating the need for troublesome limit switches.

Long Belt Life

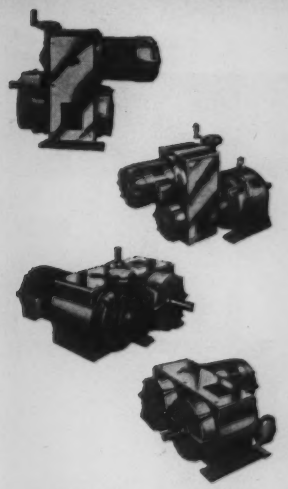
Single-cog belts with extra contact area provide more efficient transmission of power and longer belt life. Dual ventilation, precision-machined discs, equalized loading, and automatic belt tension aid in extending belt life.

Fast Belt Changing

Belt changing is fast and easy — without requiring special tools. You remove only one bearing bracket and the speed-adjusting mechanism to make fast changes without affecting permanent alignment of discs or belts.

Remote Speed Indication

A tachometer generator mounted on the output shaft operates an indicator that can be mounted at a remote location. Disassembly of the tachometer is not required when making belt changes.



Four of the many variations of mounting available with the ALLISPEDE DRIVE.

Another new product from Louis Allis

Let's look at the features of the ALLISPEDE DRIVE*

New Louis Allis Drive offers accurate control – maximum belt life – long-run economy – low-cost versatility – ease of installation

After checking the many superior features of this drive, you will prefer the Allispede every time. The illustrations at the left demonstrate the many advantages of design and construction available in this drive.

The Allispede Drive gives you high efficiency and close regulation. Belt tension adjusts automatically — and belt changes are easy and fast. The modern design eliminates overhung discs—maintains belt and disc alignment — results in longer belt life — provides the ultimate in field versatility.

Check the accompanying features — *now!* A phone call to your local Louis Allis District Office will bring a skilled Louis Allis Field Engineer. He will gladly study your drive problem and offer Application Engineering assistance. Or write to Louis Allis Company, 459 East Stewart Street, Milwaukee 1, Wisconsin for a copy of Bulletin 3600.

*ALLISPEDE is a trademark of The Louis Allis Company.

The Complete Line–

Whatever your mechanical drive application requirements, there's an ALLISPEDE DRIVE to match it exactly. Sizes up to 30 HP, output speeds from 1 to 10,000 RPM, and speed ranges up to 8:1. Motors can be open, drip-proof, enclosed, or explosion-proof; with ventilated or enclosed belt housings, suitable for foot, P-base, C- or D-flange mounting on your machine. Available with parallel shaft, or right-angle, integral gear reducers, special shaft extensions, integral magnetic brakes, electrical or mechanical remote control, and other modifications as required to meet the specifications of your application.

MANUFACTURER OF ELECTRIC MOTORS AND ADJUSTABLE SPEED DRIVES

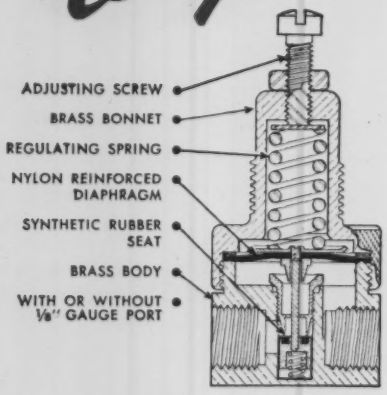
LOUIS ALLIS

Circle 467 on Page 19

Norgren PRESSURE REGULATOR

⅛" and ¼" pipe sizes

For Air, Non-corrosive Gases and Liquids



Best performance of any Regulator this small

FLOWS UP TO 20 cfm or 2 gpm at 100 psi pressure.

RELIABLE PRESSURE REGULATION even with widely fluctuating line pressure and rapidly varying air flow.

MAXIMUM PRIMARY PRESSURE: 400 psi.

MAXIMUM DELIVERY PRESSURE: 100 psi.

MAXIMUM OPERATING TEMP.: 200° F.

Compact

The small size of this regulator — only 3 1/32" high, with 1 3/8" hex body diameter (without gauge) — makes it ideal for installations where space is tight.

Low Price

The lowest price ever for a top quality, dependable pressure regulator.

For complete information

call your nearby Norgren Representative listed in your telephone directory — or **Write Factory for Brochure No. 918**

If it's Norgren...It's Dependable.

Plus these important features...

- **Easy to Install** — In-line pipe connections. May be installed in any position.
- **Easy Maintenance** — Should service be necessary, the regulator can be quickly and easily disassembled without removing from line.
- **With or Without Pressure Gauge** — 1½" gauge, 160 psi full scale reading, back mounted.
- **Flow Direction** — Right to left or left to right.
- **Panel or Bracket Mounting Available.**

C. A. NORGREN CO.

3442 SO. ELATI ST. • ENGLEWOOD, COLO.

more of the Garlock 2,000

Garlock Seals "spare" pinsetters from loss of vital oil

Garlock Klozure* Oil Seals help assure dependable operation of Brunswick-Balke-Collender automatic pinsetters by eliminating oil leakage from the gear box. At the same time, they prevent damage to the bearings by sealing out dirt and dust.

Reliability is the prime reason for specifying Klozure Oil Seals, according to Brunswick. The Seals have been in continuous use for 3½ years!

Your product, too, can enjoy long, trouble-free life like this; simply design Klozures into your application. Standard Klozures are resistant to grease and oil . . . impervious to water, mild acids, alkalies . . . non-abrasive . . . applicable from −40° F to +250° F. For extreme service conditions, Klozures are available to withstand any fluid and temperatures as high as +500° F.

Klozure Oil Seals are another part of the Garlock 2,000 . . . two thousand different styles of packings, gaskets, and seals for every need. Call your local Garlock representative, or write for Klozure Catalog 30.

*Registered Trademark

THE GARLOCK PACKING COMPANY, Palmyra, N. Y.

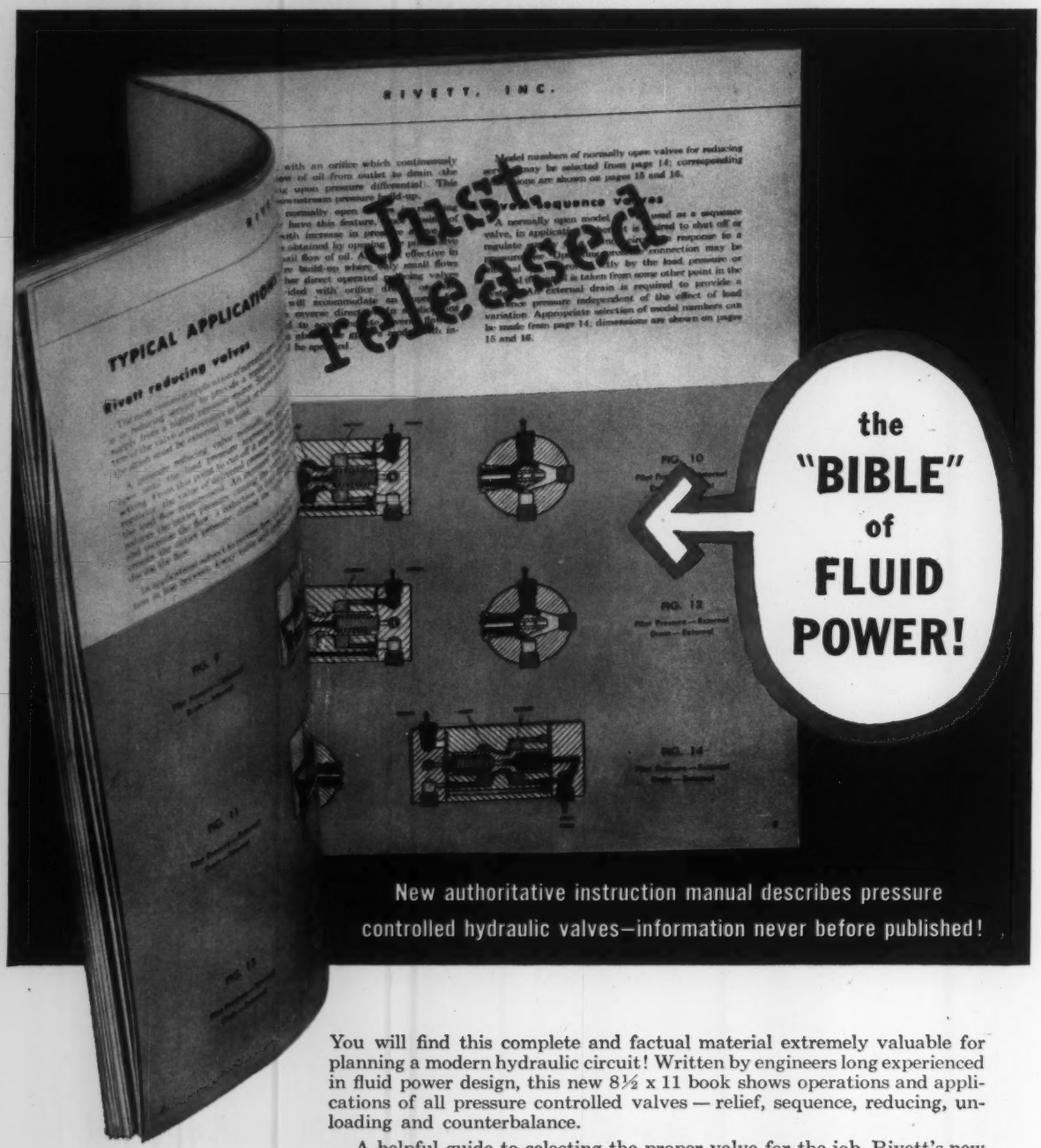
For Prompt Service, contact one of our 26 sales offices and warehouses throughout the U.S. and Canada.

GARLOCK

Canadian Division: The Garlock Packing Co. of Canada Ltd.
Plastics Division: United States Gasket Company

Packings, Gaskets, Oil Seals, Mechanical Seals, Molded and Extruded Rubber, Plastic Products

Circle 469 on Page 19



You will find this complete and factual material extremely valuable for planning a modern hydraulic circuit! Written by engineers long experienced in fluid power design, this new 8½ x 11 book shows operations and applications of all pressure controlled valves — relief, sequence, reducing, unloading and counterbalance.

A helpful guide to selecting the proper valve for the job, Rivett's new Catalog No. 230 discusses in detail all factors influencing correct choice: normal spool position, operating pressure source, pilot or direct operation. Also shown are flow diagrams, pressure vs. flow curves, ratings, dimensions, drawings and specifications.

For your free copy of Catalog No. 230, write on company letterhead to

RIVETT, INCORPORATED, DEPT. MD-11
Brighton 35, Boston, Massachusetts

RIVETT furnishes a complete power package

AIR AND HYDRAULIC — VALVES, CYLINDERS, POWER UNITS

Member—National Fluid Power Association

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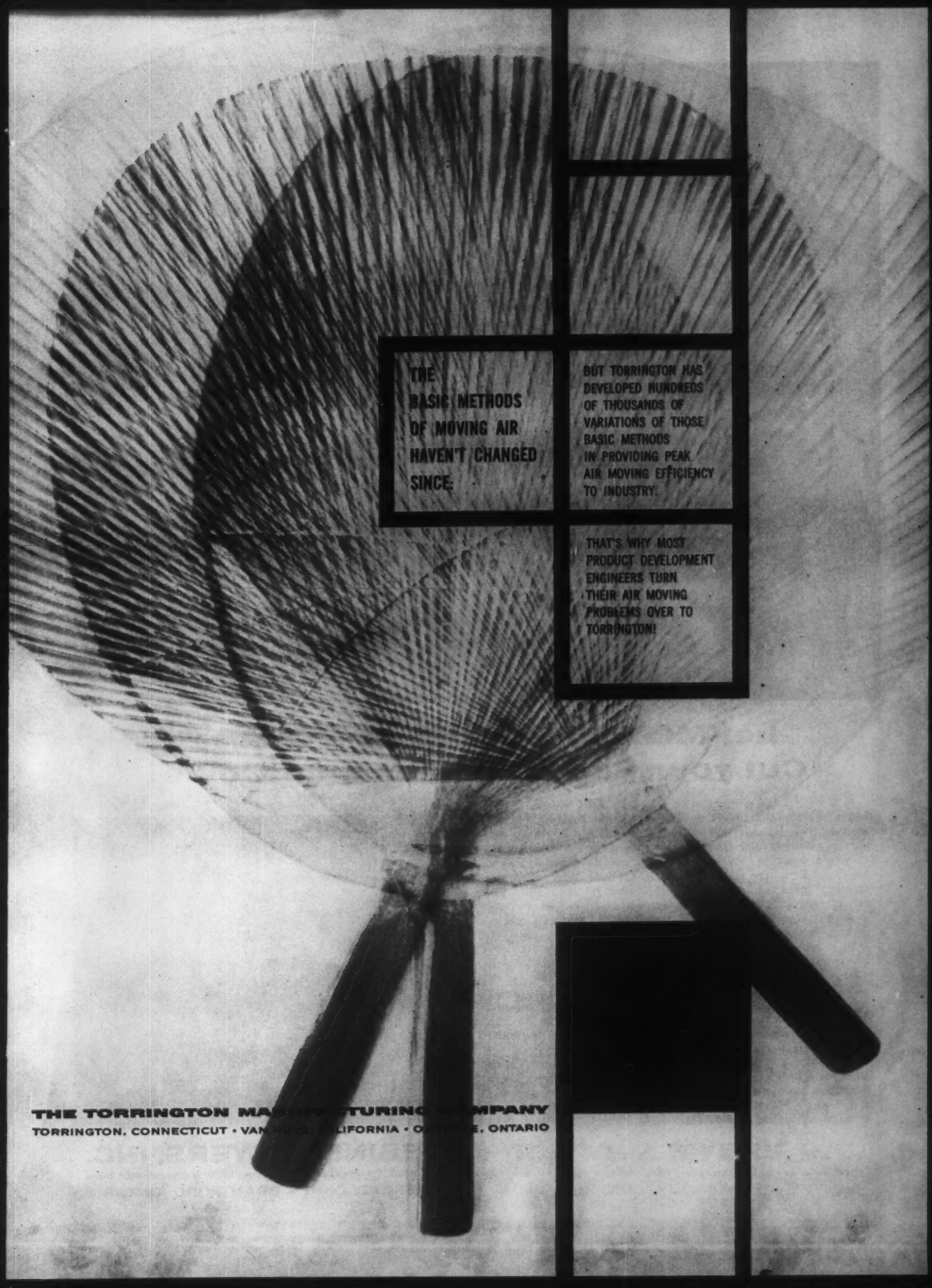
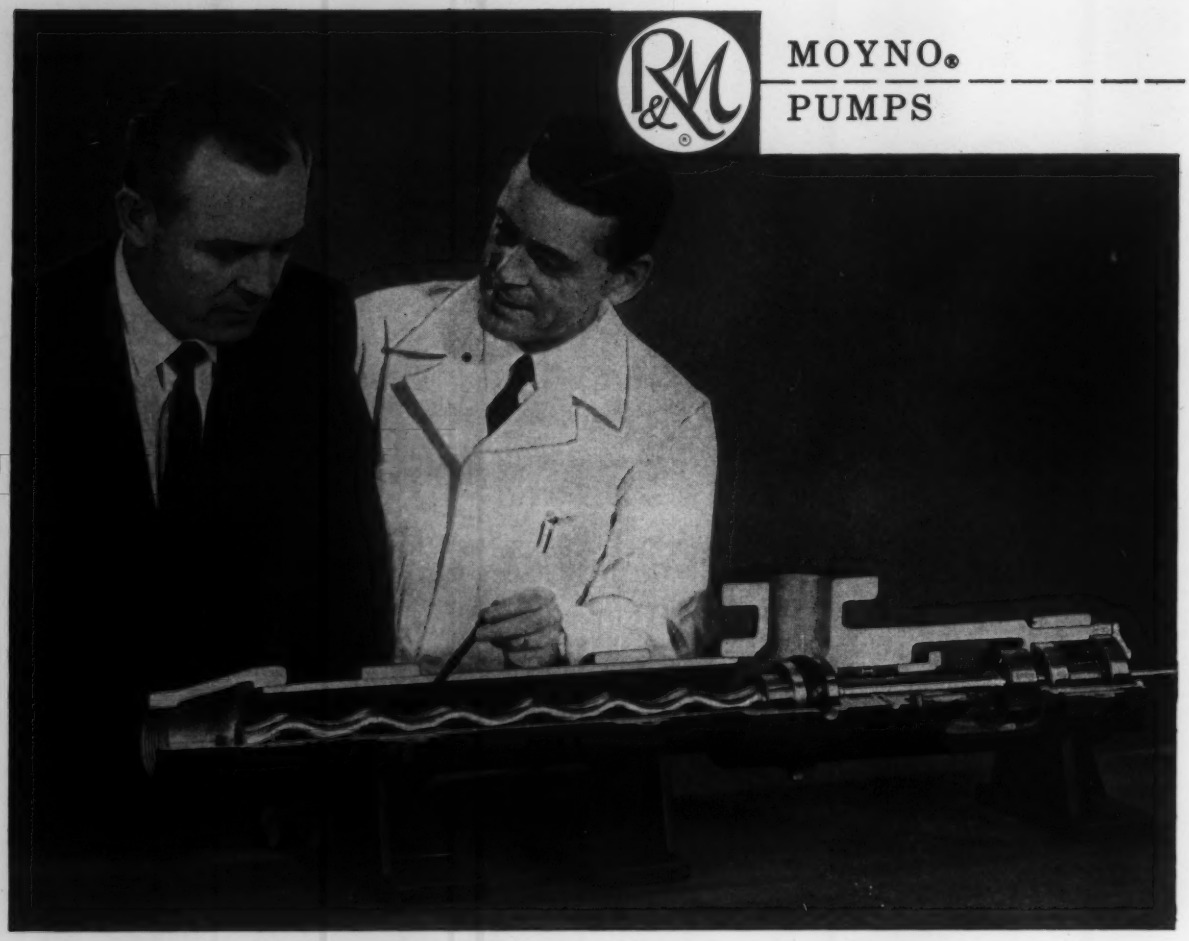
Circle 471 on Page 19→


THE BASIC METHODS OF MOVING AIR HAVEN'T CHANGED SINCE:
BUT TORRINGTON HAS DEVELOPED HUNDREDS OF THOUSANDS OF VARIATIONS OF THOSE BASIC METHODS IN PROVIDING PEAK AIR MOVING EFFICIENCY TO INDUSTRY.
THAT'S WHY MOST PRODUCT DEVELOPMENT ENGINEERS TURN THEIR AIR MOVING PROBLEMS OVER TO TORRINGTON!
THE TORRINGTON MA TURING MPANY
TORRINGTON, CONNECTICUT • VA IFORNIA • O E, ONTARIO



MOYNO®
PUMPS

Let MOYNO'S® *"Progressing Cavities"* Cut your Pump Maintenance Costs!

MOYNO's unique *"progressing cavity"* principle cuts pump maintenance costs because material being moved contacts only one moving element. MOYNOS are constructed to stoutly resist corrosion and abrasion. As shown in the cutaway model above, MOYNO's screw-like rotor revolves in a double-threaded stator forming *"progressing cavities"* that move material smoothly along, without foaming, aerating or crushing. Even where duty is so torturous that rotor and stator must be made of special resistant materials, MOYNO parts show little wear.

In industry everywhere, and on OEM applications, MOYNOS are proving "if it can be pushed through a pipe . . . MOYNO will pump it!" Typical materials pumped include non-pourable pastes, abrasive slurries, chemicals, foods, acids, even suspended solids up to one inch in size. Many materials now successfully pumped by MOYNO were once considered "unpumpable" . . . had run up prohibitive maintenance costs on other type pumps or ruined them completely.

Capacities are available up to 500 gpm and pressures up to 1000 psi. Off-the-shelf replacement parts are always immediately available. No doubt your plant flowsheet or OEM product has a spot where MOYNOS can cut costs drastically. To find out how, write today for Bulletin 30 MD

ROBBINS & MYERS, INC.

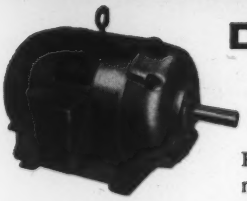
motors, household fans, Propellair industrial fans, hoists, Moyno industrial pumps

SPRINGFIELD, OHIO • BRANTFORD, ONTARIO

MOTORS

1 thru 200 horsepower

(other ratings 1/200 to 1 h.p.)

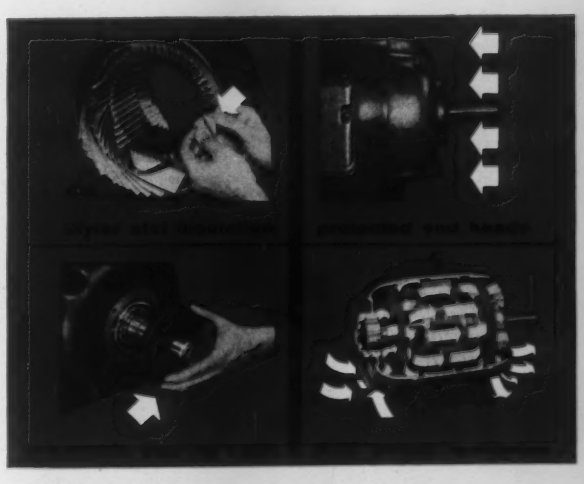


Double Width Bearings Hold More Grease...*Insure Longer Motor Life!*

Bearings in ROBBINS & MYERS motors run in double-width races with extra-large lubricant reservoirs. Bearings are fully sealed and pre-lubricated with laboratory tested grease which resists dust, temperature, humidity and high operating speeds. Tests prove these bearings can withstand six to nine years of severe service without relubrication. Bearings are further protected by metal seals on each side. Seals keep impurities out, prevent failure caused by "forgotten" lubrication or damaging over-lubrication.

R&M insures longer motor life with many additional features: Mylar* insulation that has 8 times the dielectric strength and 35 times more moisture resistance than ordinary paper insulation . . . removable caps for quick bearing inspection and relubrication . . . end heads that give full-height protection . . . dual-sweep ventilation for efficient cooling. For details, write today for Bulletin 520 MD

**DuPont registered trademark*



ROBBINS & MYERS, INC.

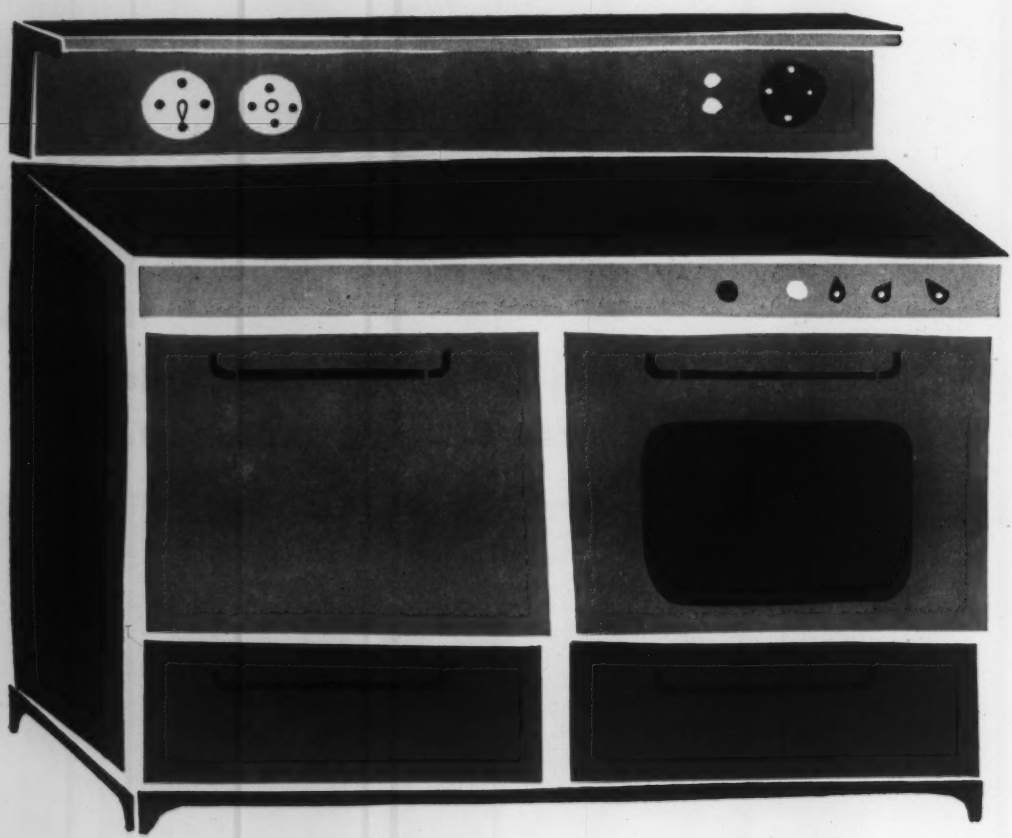
motors, household fans, Propellair industrial fans, hoists, Moyno industrial pumps

SPRINGFIELD, OHIO • BRANTFORD, ONTARIO

Circle 473 on Page 19

IF YOU'RE COOKING UP NEW WAYS TO SELL YOUR APPLIANCES, call on Brown-Lipe-Chapin right now! Let B-L-C engineers work with you at the design stage. We can help you add new sparkle to your product and help spark sales with Dura-Plate—the first major advance in chrome plating in the past twenty-five years. Also, under the same roof at Brown-Lipe-Chapin, you'll find mass-production facilities for quality, precision die casting and metal stamping. And for the finishing touch, there're facilities to anodize, polish and buff, electroplate and precision-paint any parts. Two plants, strategically located at Syracuse, New York and Elyria, Ohio, are ready to serve you with the same under-one-roof facilities. For further information, call or write Brown-Lipe-Chapin, Syracuse, New York.

BLC



GM GENERAL MOTORS

RELIABILITY by BROWN·LIPE·CHAPIN

DIVISION OF GENERAL MOTORS CORPORATION

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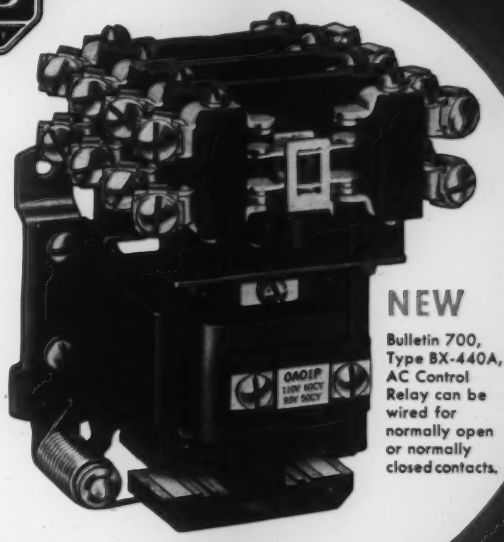
Circle 475 on Page 19→

A New Era
in
Relay Life and Reliability

NEW
Bulletin 700, Type B-220A, AC Control Relay with 2 N.O. and 2 N.C. contacts.



NEW
Bulletin 700, Type BX-440A, AC Control Relay can be wired for normally open or normally closed contacts.

NEW ALLEN-BRADLEY BULLETIN 700 RELAYS

Improved features set new performance standards

For years, Allen-Bradley Bulletin 700 Type B and Type BX relays have been preferred for their long life and trouble free operation. The improvements in the new Bulletin 700 Type B and Type BX relays will set new performance standards wherever they are used. Naturally they use the famous A-B double break, silver alloy contacts which always remain in perfect operating condition without cleaning or filing. The cast coil cannot be damaged by the severest atmospheric conditions.

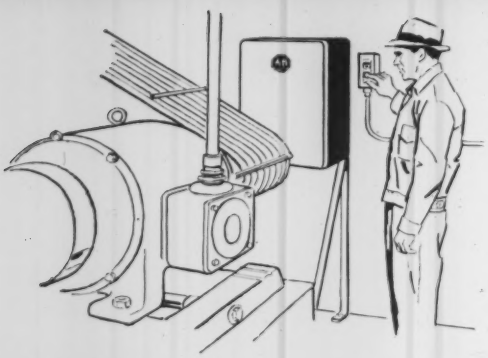
These new Allen-Bradley Bulletin 700 Type B and Type BX relays offer even greater value and greater reliability than ever before—but the price has not been changed.

- **New mechanical design gives at least 5 times greater operating life.**
- **New contact motion provides 10 times greater electrical reliability.**
- **Complete interchangeability—mounting dimensions are unchanged.**
- **New hermetically sealed plastic coil fits Bulletin 700 relays presently in use.**
- **New, stronger, movable contact crossbar—also fits old relays.**
- **New reinforced stationary contact blocks—interchangeable with previous design.**

Allen-Bradley Co., 1316 S. Second St., Milwaukee 4, Wis.
In Canada: Allen-Bradley Canada Ltd., Galt, Ont.

9-59-MR

ALLEN-BRADLEY Quality Motor Control
Member of NEMA

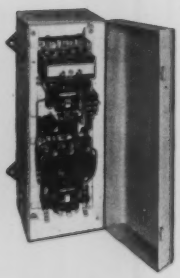


WHEN REDUCED VOLTAGE STARTING IS A MUST

Only Allen-Bradley can provide all the answers

The Allen-Bradley line of reduced voltage starters makes possible a selection of the best starter, not only to meet the power company's requirements but also to provide the best starting conditions for the motor and the "load" that it drives.

The simple solenoid contactors in A-B reduced voltage starters have only ONE moving part—assuring millions of trouble free operations. And their double break, silver alloy contacts never need costly maintenance. Accurate, reliable overload relays protect motors against burnouts. Write for Publication 6088.

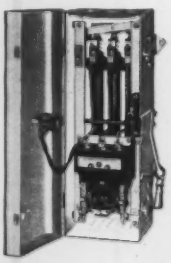


Bulletin 740

Graphite disc resistors are automatically inserted in series with the squirrel cage motor at starting, and they are automatically cut out after a predetermined time. Turning a single screw on the starter frame adjusts the compression resistors exactly to motor and load conditions for velvet smooth acceleration. Ratings to 200 hp, 220-440-550 v.

Bulletin 640

Where remote control is not needed, these graphite compression disc resistor starters provide stepless acceleration of squirrel cage motors. Operated by hand lever, the smooth starting of the motor is under the control of the operator. No-voltage and dependable overload protection is provided. Ratings to 200 hp, 220-440-550 v.



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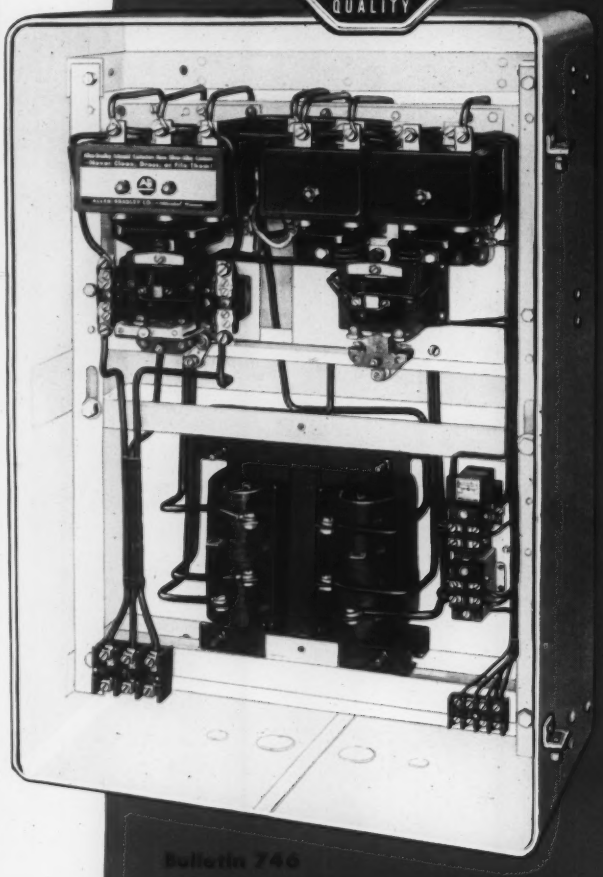
A-B QUALITY



Bulletin 740

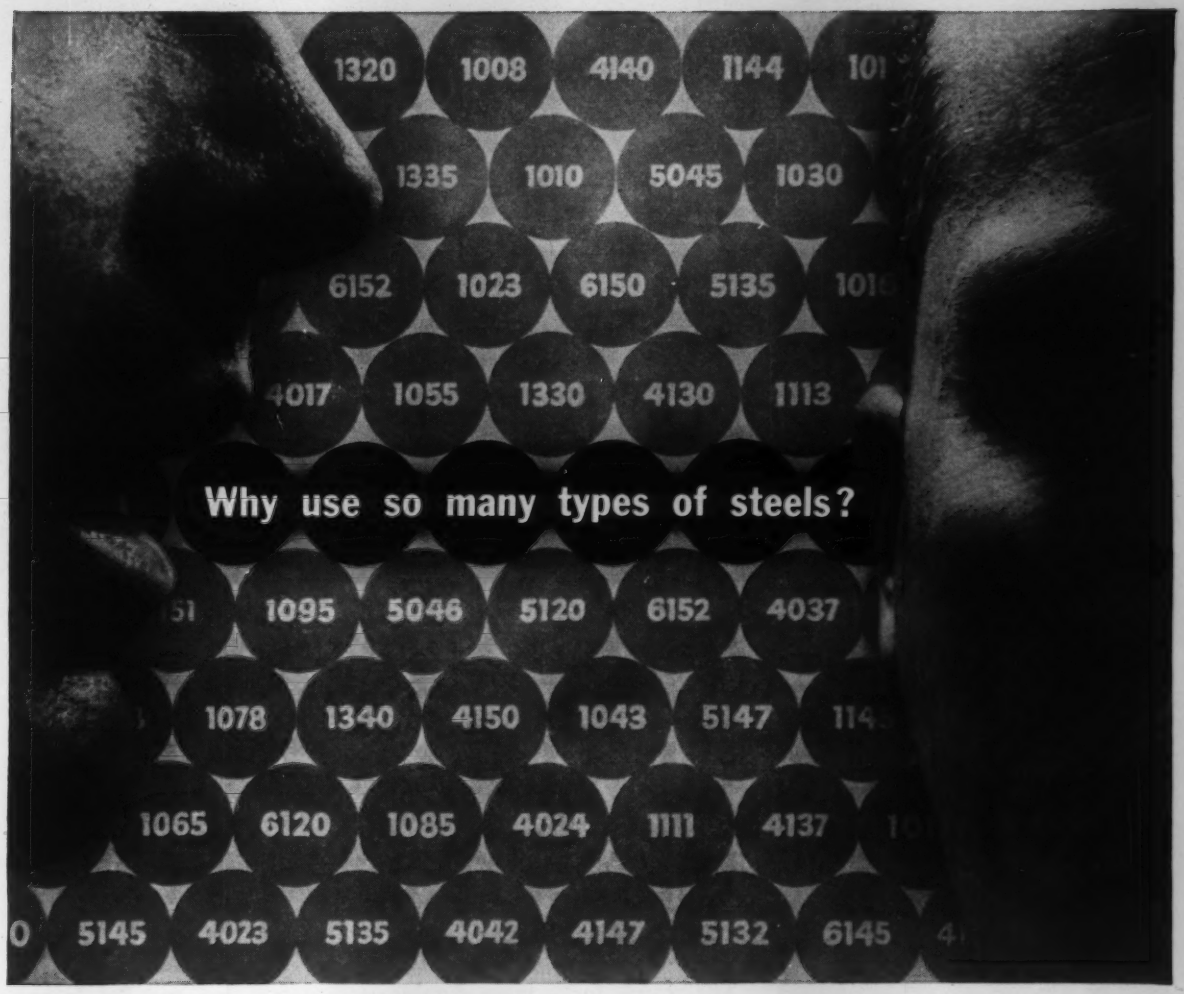
Automatic reduced voltage starter for squirrel cage motors that should not be started on full line voltage. It employs autotransformer connected in open delta to reduce line voltage during starting. Adjustable timing relay controls starting period. Taps are provided on the autotransformer to adjust the starting voltage applied to the motor. Ratings to 300 hp, 220 v; 600 hp, 440-550 v.

ALLEN-BRADLEY

Member of NEMA

Quality Motor Control

Allen-Bradley Co., 1316 S. Second St., Milwaukee 4, Wis.
In Canada: Allen-Bradley Canada Ltd., Galt, Ont.



Just two will do...
4340, 4620 General Purpose Steels

You make your job easier and you standardize, simplify, and save money...

These two General Purpose alloy steels can solve most of your steel selection problems. One a carburizing type . . . the other a through-hardening type — with just these two alloy steels you can satisfy practically all your engineering requirements.

Here's your chance to standardize on materials. To simplify inventory and processing. To save money in purchasing, inventory, production . . .

When you need through-hardening steel, simply specify 4340. It's ideal for parts of any section size. It provides exceptionally high strength and toughness. Responds reliably to heat treatment. It's weldable under proper conditions and machines at relatively high hardness.

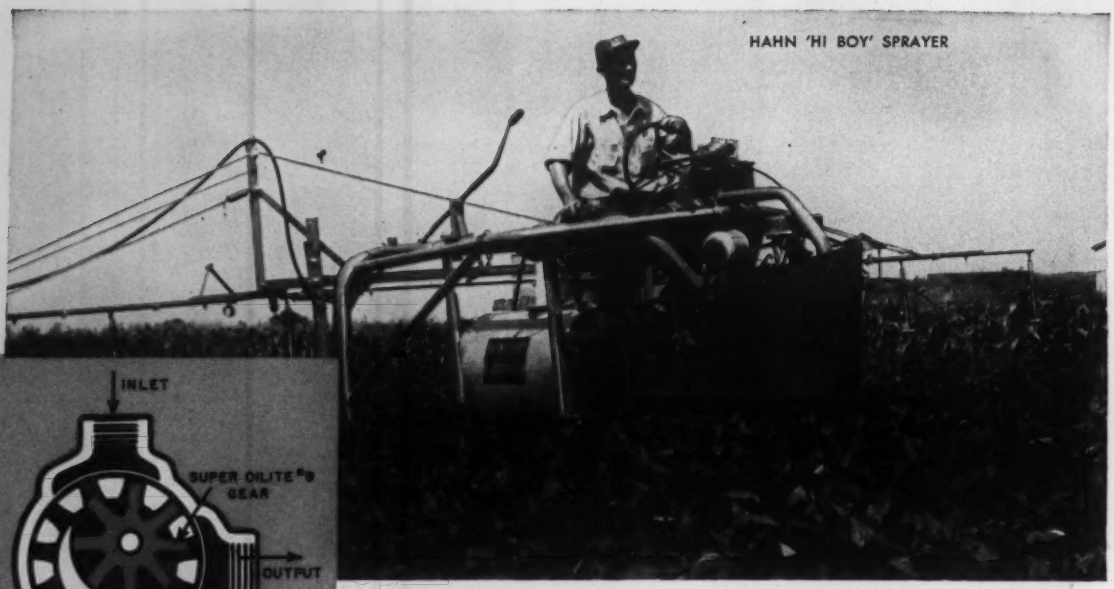
And when you want to carburize, simply specify 4620 steel. It resists warpage and distortion in heat treatment. Responds reliably and uniformly, too. Provides a tough, strong core to support the hard wear-resistant case.

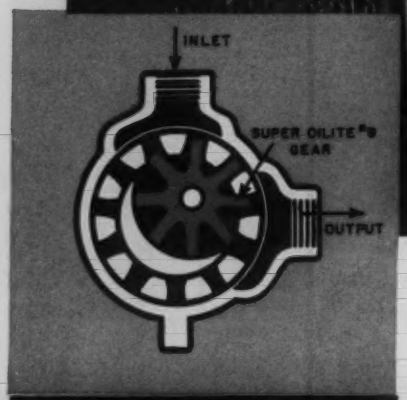
Best of all, both are carried by Steel Service Centers from coast to coast, ready for delivery right off the shelf. If you need heavier-duty or special purpose steels for very particular applications, suitable nickel alloy steels are also available from your Steel Service Center. To get a buyer's guide of centers that carry 4340, 4620, and other nickel-containing grades, simply write Inco.

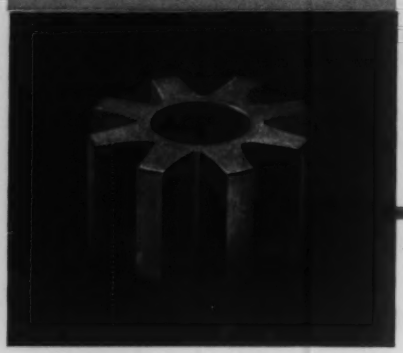
AMERICAN STEEL WAREHOUSE ASS'N.

THE INTERNATIONAL NICKEL COMPANY, INC.
67 Wall Street
New York 5, N. Y.

INCO TRADE MARK







Double Sprayer Output, Cut Costs 75% with Oilite Precision Gear

The search for a more durable star gear at less cost led Hahn, Inc., Evansville, Indiana to investigate Amplex powder metallurgy. Amplex engineers came up with an answer that far exceeded Hahn's expectations.

Formerly machined from cast bronze, the gear is now produced in a single press operation of hardened Super Oilite No. 9†. By eliminating scrap and machining operations like turning, boring, cut-off and hobbing, Amplex reduced the cost of the gear approximately 75%. But that's not all . . .

Despite exposure to acid-forming, gritty fertilizers and pesticides, the oxide-coated Oilite gear proved 5 times more durable than its predecessor! Tough Super Oilite No. 9 proved so remarkably wear-resistant, Hahn was able to double the pump's gpm output.

What do *you* look for in components—lightweight, close tolerances, corrosion resistance, wear resistance or superior surface finish? Amplex can supply quality-controlled parts in volume that meet *all* of these requirements.

To put superior performance at less cost into your products, contact the nearest Oilite Engineer. Look for him in the Yellow Pages under "Bearings" or write Department S-11.

† Only Chrysler makes Oilite

QDP or PDQ?*

Why risk excessive production and warranty costs? You can depend on Amplex for top *quality* components, prompt *delivery* and a reasonable *price* . . . QDP! The result is parts that reduce your manufacturing and selling costs.

* Quality-Delivery-Price vs. Price-Delivery-Quality

SINCE 1929 — A CHRYSLER OILITE PRODUCT

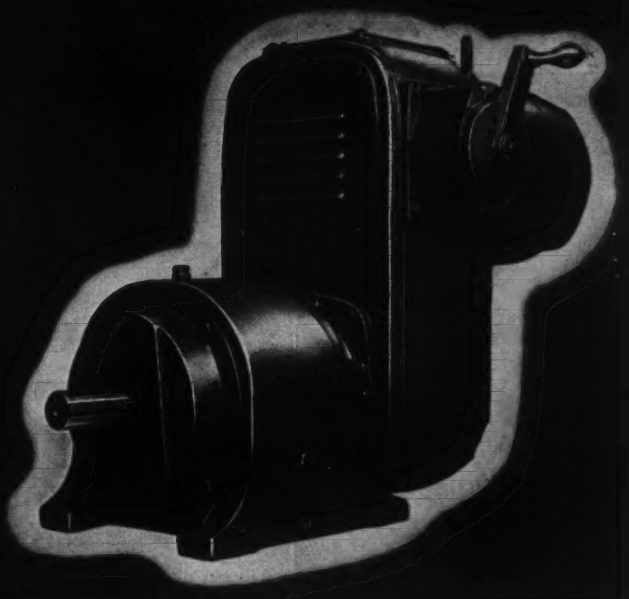
the most trusted name in powder metallurgy!

AMPLEX DIVISION

CHRYSLER CORPORATION, DETROIT 31, MICHIGAN

PRECISION PARTS • SELF-LUBRICATING BEARINGS • METAL FILTERS • FRICTION UNITS

Circle 476 on Page 19



NEW General Electric Polydyne* drive provides

DEPENDABLE LOW-COST ADJUSTABLE SPEED

straight from a-c power in ratings from 1/4 to 25-hp!

General Electric's new Polydyne drive is a compact, completely packaged unit consisting of a-c driving motor, belt transmission, output gearing and control.

NOW IN STOCK—These factory- and field-tested drives are available in configurations and ratings to meet virtually all your requirements!

G-E Polydyne drive has a completely new control design that prevents binding or sticking of speed control mechanism, and it responds smoothly and quickly to speed adjustment. Polydyne mechanical adjustable-speed drive is the drive to use when and where you want:

- Most efficient process speed
- Maximum machine life
- Minimum maintenance requirements
- Machine versatility

EASY MAINTENANCE—Advanced design makes belt changing fast; reduces chance of damage to drive shaft and bearings during belt change and eliminates shaft realignment after change.

General Electric helical reducer gears can be removed as a unit for fast inspection, and Polydyne drives require minimum lubrication.

FOR MORE INFORMATION on G.E.'s complete PLUS LINE with Polydyne drive, contact your nearby G-E Apparatus Sales Office or Distributor, or write for bulletins: Polydyne Drive (GEA-6806), G-E Helical Gear Motor Line (GEA-6704), Shaft-mounted Speed Reducers (GEA-6616), Fractional Horsepower Gear Motors (GEA-6133A), Section 854-2, General Electric Co., Schenectady, N. Y.

* Trademark of General Electric Company.

You get all these PLUS VALUES with General Electric Mechanical Power Transmission Equipment

PRODUCT APPLICATION SERVICE—G-E engineers are available to help you analyze and select the right equipment for your job.

PROMPT SHIPMENT—You get fast delivery on all standard General Electric units—from distributor or factory stocks.

SALES SERVICE—Your inquiries, quotations and requests for bids are handled promptly by G-E field service offices.

AFTER SALES SERVICE—50 G-E Service Shops and 500 authorized Small Motor Service Stations offer expert repair service on all G-E Gear Motor products.

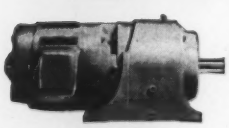
MANUFACTURER RESPONSIBILITY—G.E. focuses manufacturing responsibility at one source, for it produces *all* gearing, components and motors in its line.

MANUFACTURER REPUTATION—Advanced technology built into G-E mechanical power transmission equipment assures you that it will meet your specifications—adds to and builds preference for your product.

Progress Is Our Most Important Product

GENERAL ELECTRIC

Choose from General Electric's PLUS LINE of Mechanical Power Transmission Equipment

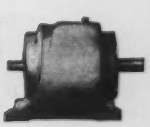


Integral-type gear motor

Right-angle shaft gear motor

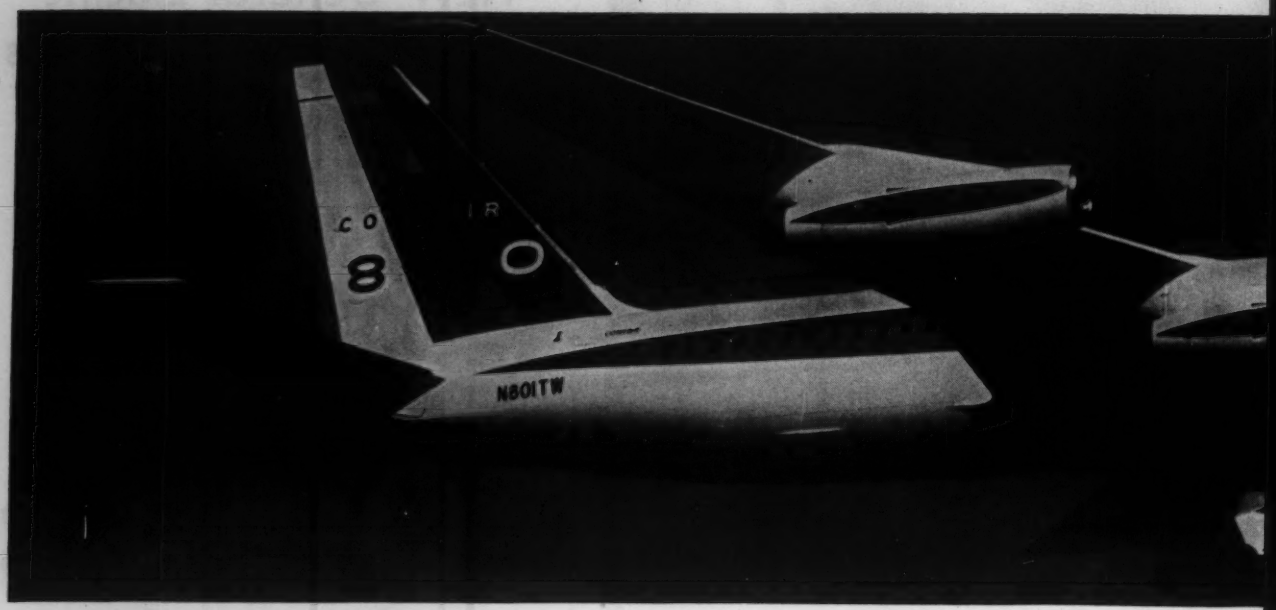
All-motor gear motor

Offset-shaft gear motor



Helical speed reducer

Shaft-mounted speed reducer



Republic High-Performance

STAINLESS STEEL IS USED IN LEADING EDGES of the 880's vertical fin and horizontal stabilizer where anti-icing is accomplished through electrical heating of the metal. Use of Republic ENDURO Stainless Steel increases strength and heat-resistance, permits thinner, lighter gages. Types 301 and 302 are readily formed into desired shapes by cold-forming, drawing, and bending operations. Mail coupon for complete details.

Circle 477 on Page 19A

In the Convair 880—the world's fastest jet airliner—speed, economy, and medium-range operating requirements dictated the use of thousands of pounds of *high-performance* metals. Working closely with design engineers, Republic Steel supplied:

TITANIUM to increase strength-to-weight ratios . . . permit lighter weight with increased strength.

ENDURO® STAINLESS STEEL to increase heat and corrosion-resistance at elevated temperatures.

ALLOY STEEL to increase strength of major structural components . . . provide an extra margin of "beef."

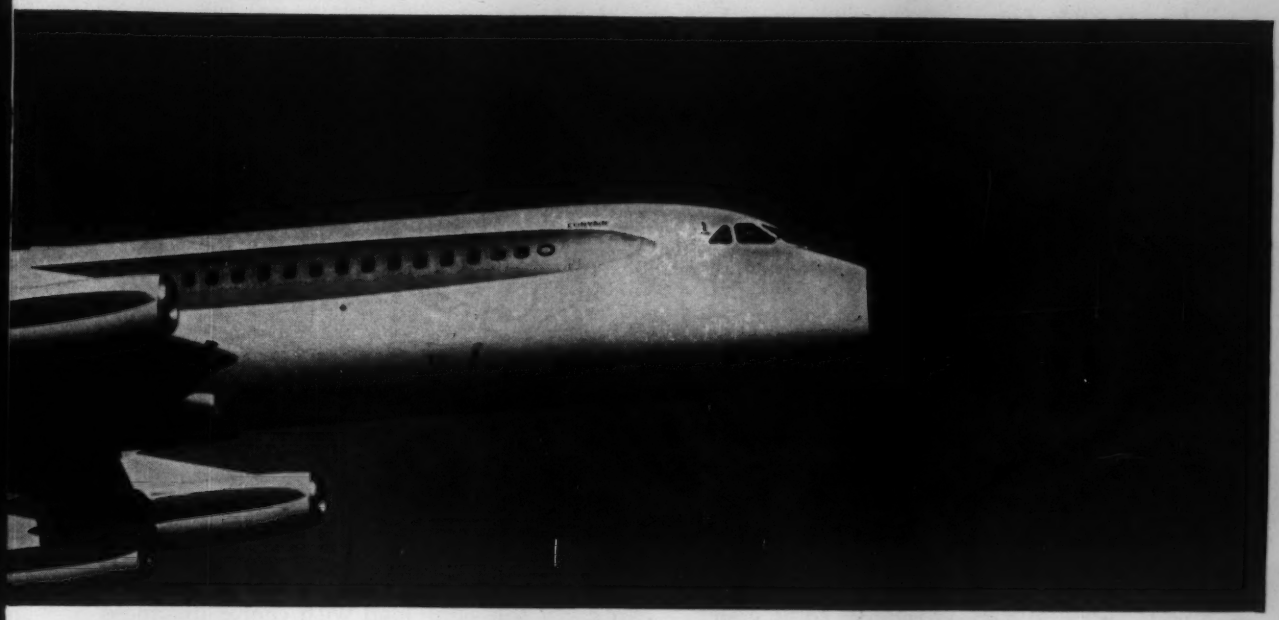
Republic has pioneered in the development and production of new metals to increase strength, resist heat, reduce weight. With constantly expanding research as well as production facilities and capabilities, Republic is the nation's largest producer of *high-performance* metals —titanium, stainless, and alloy steels.

Let us help you find the most advantageous uses of these metals in *your* project. Return the coupon for complete information without obligation. Please indicate if you would like a Republic Metallurgical Specialist to call.

REPUBLIC

REPUBLIC STEEL®

World's Widest Range of Standard Steels



Metals for the 880

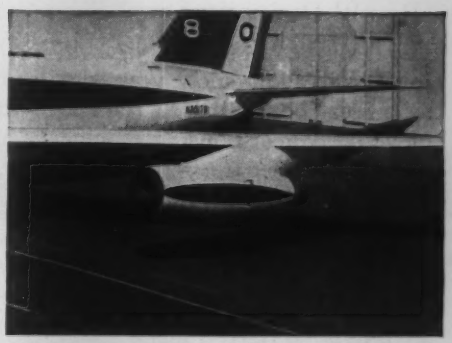
IN EACH 880 POD-PYLON, rear engine mount "horseshoe" frame — of nickel-plated, chrome-alloy steel — grips the powerful General Electric CJ-805-3 engine. Republic Alloy Steels offer exceptionally high strength-to-weight ratios with the highest strength values. Uniform response to heat treatment assures complete deep hardening penetration, plus hard, wear-resistant surfaces. Send for additional information.

Circle 478 on Page 19A

REPUBLIC'S NEW HIGH-STRENGTH POWDER, TYPE HS6460,

is ideal for sinterings of highly stressed components. Provides minimum tensile strength of 60,000 psi at 6.4 density as sintered . . . 100,000 psi after heat treatment. Less than .004% shrinkage from die size at 6.4 density. Available in quantities up to and including 12 tons or multiples. Can be used with existing operating equipment. Mail coupon for technical data sheet.

Circle 479 on Page 19A



MAJOR 880 TITANIUM USES are (1) fixed outboard nacelle assembly—107.8 pounds per nacelle, 215.6 pounds per airplane; (2) lip assembly anti-icing nose cowl—53.8 pounds per nacelle, 215.2 pounds per airplane; and (3) right hand access door assembly—41.2 pounds per nacelle, 164.8 pounds per airplane. Republic supplies a major portion of the 870 pounds of titanium that goes into each Convair 880.

Circle 480 on Page 19A

STEEL

and Steel Products

REPUBLIC STEEL CORPORATION
DEPT. MD -7818
1441 REPUBLIC BUILDING • CLEVELAND 1, OHIO

Have a metallurgist call:	Send more information on:
☐ Alloy Steel	☐ Alloy Steel
☐ Stainless Steel	☐ Stainless Steel
☐ Titanium	☐ Titanium
☐ Type HS6460 Metal Powder	☐ Type HS6460 Metal Powder

Name_____ Title_____

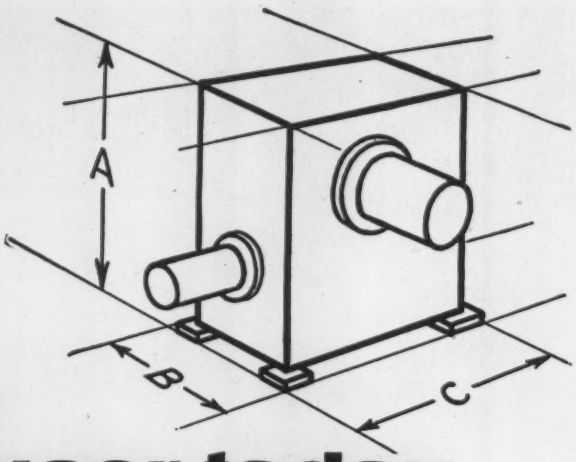
Company_____

Address_____

City_____ Zone____ State_____

(Advertisement)

Do-It-Yourself...



Let's design a speed reducer today

So you can't find a speed reducer to fit your latest brainchild without ruining the design? Doggone manufacturers all build reducers too big to fit into those few cubic feet you've got left for the reduction unit back behind the double-ended dingbat?

Revolt! Design your own! Show 'em!

By George, design it yourself and it'll fit. How? Well, you know your size limits. Draw the biggest box that'll fit the space and you've got your reducer housing specifications.

Now you need gears that will (1) transmit the needed horsepower under all operating conditions, (2) provide the ratio your machine requires and (3) fit the space that's available. You'll soon discover that there are limits to what gears can do in transmitting horsepower. The cheapest answer is parallel shaft helical gears. If they'll fit you're in clover. But they take the most room, especially when you're out of the fractional hp range. The right angle worm and gear combination is the most compact drive arrangement.

Here again you have a choice. Cylindrical worm gearing is often used, and if it'll do the job, is worth consideration. But it's not the most compact possibility. The best way to shrink gears and still carry the load is the double-enveloping worm gear design. Both worm and gear are throated and the two literally wrap around each other. This brings center distance of the two shafts closer together and you can put them inside smaller housings.

Does this reduce load capacity? No sir! You can carry the same load with center distances up to 33% smaller than those of cylindrical worm gears. Or use the same center distance and carry a greater load. Will these gears hold up in operation? Sure, if you beef up the teeth, the bearings and the housing. Use straight-sided worm and gear teeth and you'll get all the strength there you'll ever need. Use large taper roller bearings with real B-10 life. Use a reinforced, heavy wall housing that won't distort under load. Put fins on it for added cooling and increased thermal horsepower capacity to meet your needs. Now, put the whole thing together and you've got a speed reducer that's a dilly.

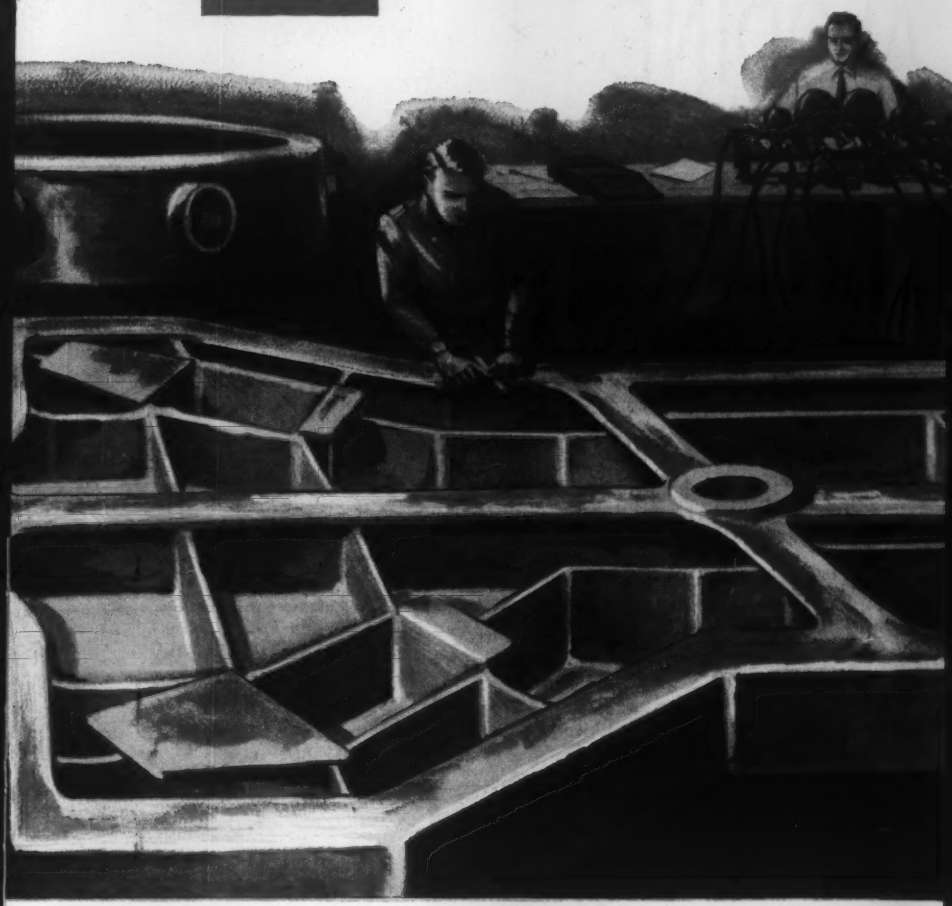
Designing your own speed reducer give you a headache? Looking for an easier way? There is one. Someone's already done exactly what you're talking about. You can order that compact speed reducer right off the shelf. Where?

Cone-Drive Gears, that's where!

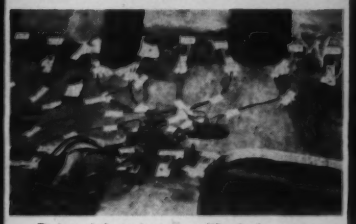
Yes sir. They stock double-enveloping worm gear speed reducers from fractional to 665 hp. Standard ratios from 5:1 to 70:1 in about 15 increments, all interchangeable in any type housing of a given center distance. Worms over and worms under. Gear shafts vertical, too. Single- or double-extended output shafts, or shaft mounted. Over 200,000 combinations possible. Wow! Just about anything you want.

Better get Cone-Drive's new speed reducer catalog that details everything. Ask for Bulletin CD-218. Cone-Drive Gears, Div. Michigan Tool Co., 7171 E. McNichols Rd., Detroit 12, Mich.

...where industrial progress is cast in steel



Locating high stress points with brittle lacquer.



Determining stresses with strain gages.

Dynamic testing under service conditions.

ENGINEERED TESTING...For design verification and improvement

General Steel's activities extend far beyond the manufacturing process . . . into the area of checking existing designs for product improvement, and verifying new designs.

For example, the General Steel test laboratory employs the latest stress analysis techniques and the most modern equipment to conduct brittle lacquer and strain gage analyses under controlled atmospheric conditions. Multi-directional static load tests, dynamic tests under actual service conditions, and many other types of tests are conducted to develop better cast steel structures and steel castings for use in the cast-weld and composite structures of your product.

This assurance of quality from planning to performance is available to you. Let us demonstrate how you can use it . . . profitably.

Write for folder **How General Steel Castings Can Improve Product Design and Performance.** General Steel Castings, Station 260 Granite City, Illinois

GENERAL STEEL CASTINGS

GRANITE CITY, ILL. • EDDYSTONE, PA. • AVONMORE, PA.

Circle 422 on Page 19

a new, improved ALODINE for aluminum

Cost Saving, Time Saving ALODINE 1200S Pre-Paint Treatment Protects Aluminum Best!

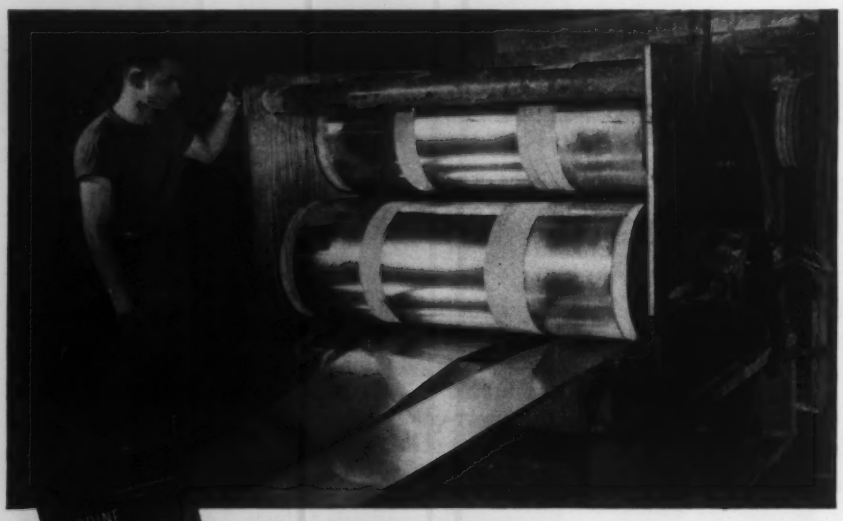
IN LESS TIME—ALODINE 1200S provides increased chemical activity for dramatic reduction in processing time . . . up to 50% in most cases! You get far faster processing than ever before, with the same high quality protection!

WITH LESS EQUIPMENT—You can install an ALODINE 1200S system quickly and conveniently, *without resorting to mechanical bath maintenance!* That means no dangerous, time consuming checking routines with the possibility of bath contamination always present!

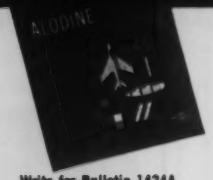
AT LESS COST—ALODINE 1200S can be processed through continuous dip in the same time cycle other conversion coatings require for continuous spray lines! This dip technique reduces initial equipment costs, slashes maintenance costs to a minimum and allows aluminum fabricators to utilize conversion coatings more frequently for a wider range of product applications! Whatever the application method—brush, dip, continuous strip or spray—ALODINE 1200S may be the answer to your production problems.

FOR MORE FLEXIBILITY—Most important, its ease of operation, safety in use and versatility enables ALODINE 1200S to answer one of the most perplexing problems inherent in providing corrosion protection and paint bonding qualities for aluminum—the problem of constant, uniform quality. ALODINE 1200S is qualified under Government Specification MIL-C-5541.

Investigate cost saving, time saving ALODINE 1200S today! And whenever you have a chemical finishing requirement for aluminum—any type of aluminum—there's an ALODINE process available to protect or decorate the metal, and anchor the paint finish more securely.



Typical ALODINE 1200S strip line installation at ALSCO, INC. Strip from aluminum coil is fed into Alodine processing baths where it is cleaned, rinsed, deoxidized, rinsed, coated with ALODINE 1200S, rinsed and given a final acidulated rinse. Strip is then rewound, roll coat painted, roller formed into final shape, backed, inspected and packed for final shipment.



Write for Bulletin 1424A describing use of Alodine for aluminum fabrications of all types.

AMCHEM

ALODINE 1200S

another chemical development of **AMCHEM PRODUCTS, INC., Ambler 18, Pa.**
(Formerly American Chemical Paint Co.)

Detroit, Mich. • St. Joseph, Mo. • Niles, Calif. • Windsor, Ont. Amchem and Alodine are registered trademarks of Amchem Products, Inc.

CATERPILLAR SELECTS VICKERS VANE PUMPS

"HIGH PERFORMANCE" PUMPS PICKED FOR NEW SERIES H EQUIPMENT

Continuing critical selection and evaluation of all component items used on its machines helps make Caterpillar Tractor Co. outstanding in its field. Thorough engineering, advanced manufacturing, and top-quality materials result in cost-cutting construction equipment . . . the new D8 Series H Tractor, No. 8 Ripper and No. 583 Series H Pipelayer.

To assure dependable hydraulic power on these machines, Caterpillar specifies the Series 25, Series 35 and Series 45 Vickers "High Performance" Pumps as original equipment.

VICKERS "HIGH PERFORMANCE" PUMPS (larger sizes and double pumps soon to be released) represent the most complete range of high speed, high pressure pumps for construction and material handling equipment ever offered. Send for **BULLETIN M-5108** for further information and performance characteristics.

Complete pump overhaul in 10 minutes in the field...

Replacement cartridges for "High Performance" pumps contain all normal wearing parts and insure "As New" results. Following vehicle manufacturer's instructions, cartridge can be quickly changed without removing pump from vehicle and usually without disconnecting hydraulic lines. Caterpillar Dealers provide cartridges and replacement service in the field.

8282

VICKERS INCORPORATED
DIVISION OF SPERRY RAND CORPORATION
Mobile Hydraulics Division
ADMINISTRATIVE and ENGINEERING CENTER
Department 1430 • Detroit 32, Michigan

Application Engineering Offices: • ATLANTA • CHICAGO • CINCINNATI CLEVELAND • DETROIT • HOUSTON • LOS ANGELES AREA (El Segundo) MINNEAPOLIS • NEW YORK AREA (Springfield, N.J.) • PITTSBURGH AREA (Mt. Lebanon) • PORTLAND, ORE. • ROCHESTER • SAN FRANCISCO AREA (Berkeley) • SEATTLE • ST. LOUIS • TULSA
ALSO SOLD AND SERVICED IN AUSTRALIA, ENGLAND, GERMANY & JAPAN
IN CANADA: Vickers-Sperry of Canada, Ltd., Toronto, Montreal & Vancouver

ENGINEERS AND BUILDERS OF OIL HYDRAULIC EQUIPMENT SINCE 1921

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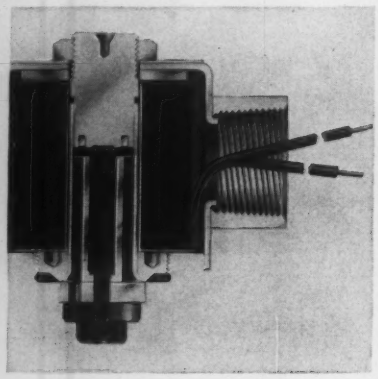
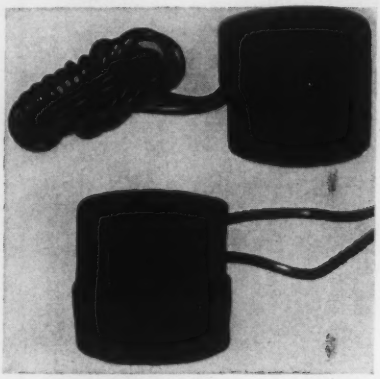
Skinner introduces Two-Way Solenoid Valve for Control of High Pressures

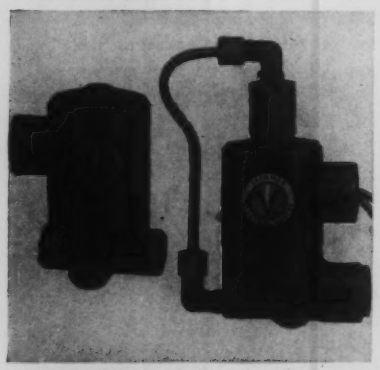
New High Pressure Models just added to the Skinner two-way Type R series line of pilot-operated solenoid valves are offered in two-way normally closed construction only. Orifice size is ¼" diameter with ¼" NPT ports. Operating pressure differentials: 5 to 1250 psi on AC voltages and 5 to 1000 psi on DC voltages. Designed for use with such media as air, oil, water and semi-corrosive liquids.



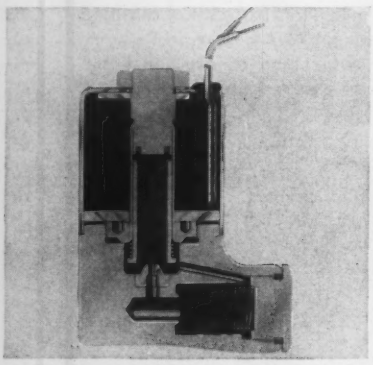
Features. New Skinner Models are built to U. L. requirements in standard and explosion-proof construction. V5-2H type solenoid operator contains stainless steel internal parts to resist corrosion. Valve body is forged naval brass and contains stainless-steel piston assembly, precision machined to close tolerances for positive opening and closing of the main orifice.



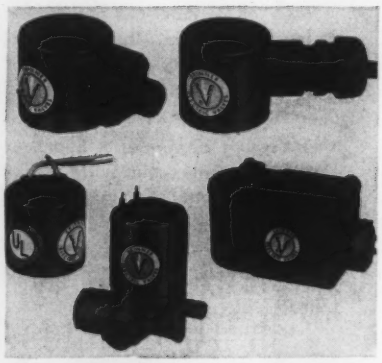
Variety of Coil Voltages. Standard coils, built to U. L. standards, are varnish-impregnated and moisture-resistant. Molded waterproof coils are available that will even operate under water and are resistant to fungus growth. Coils are available in wide range of voltages and frequencies.



Standard Pressure Two-way R Series Valves. These two-way valves are available in standard and explosion-proof construction, normally open or normally closed. Pressure operating differentials are 5 to 200 psi for normally closed and 5 to 150 psi for normally open.



Many Desirable Features: Standard pressure R series two-way valves have V5 type operator; stainless steel internal parts; naval brass body; stainless-steel piston assembly; soft synthetic inserts for bubbletight operation. Normally open models have piped-body return. Valve can be mounted in any position.



Custom Installation with these Options. There is a large selection of electrical housings that can be rotated 360° for easy connecting. Also available is manual override that permits opening or closing the valve in the event of current failure.

Skinner Solenoid Valves are distributed nationally.

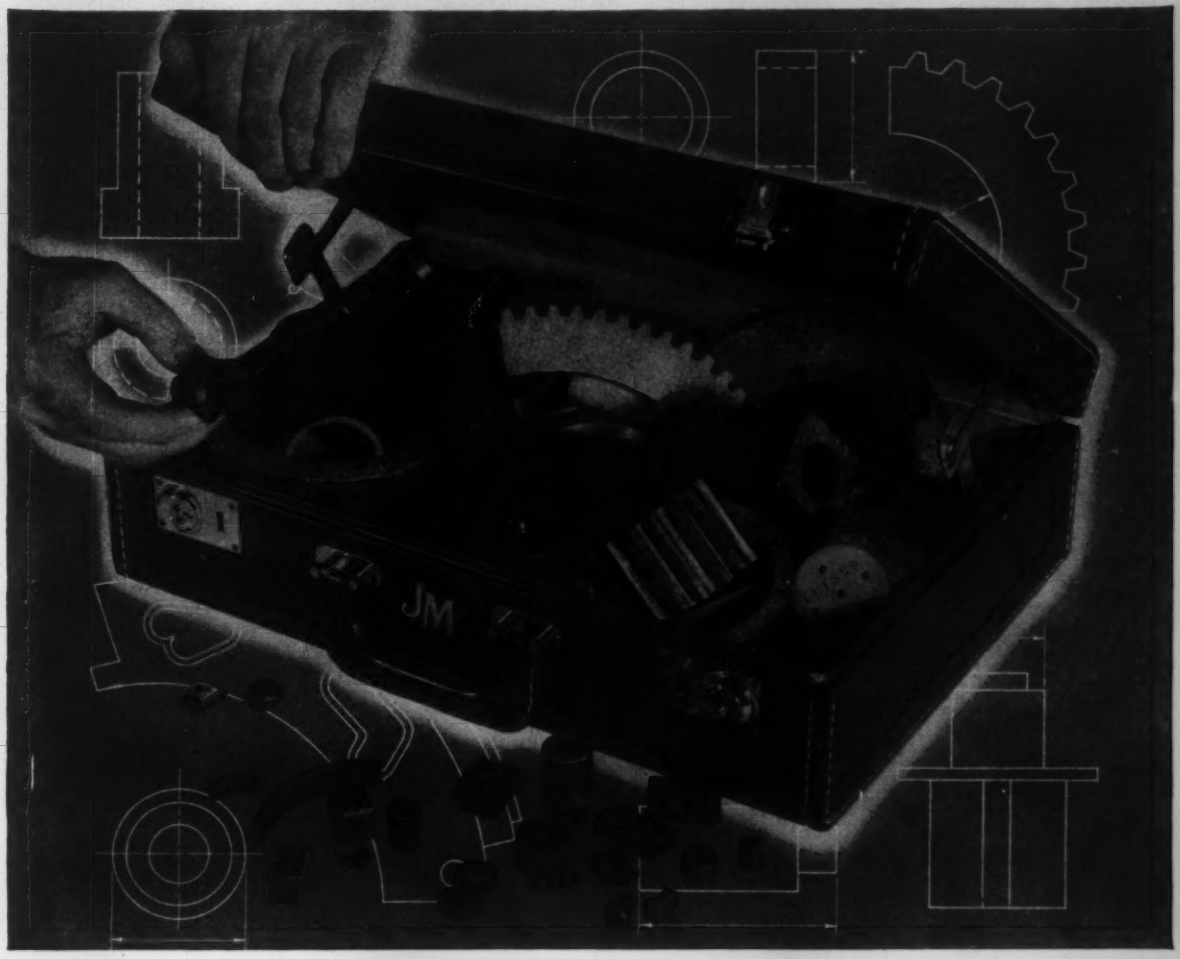
For complete information, contact a Skinner Representative listed in the Yellow Pages or write us at Dept. 42N.

SKINNER ELECTRIC VALVES

THE CREST OF QUALITY **THE SKINNER ELECTRIC VALVE DIVISION • NEW BRITAIN, CONNECTICUT**

Circle 486 on Page 19

When it's time to pick the best friction materials for your latest clutch or brake design



The J-M Friction Specialist is a good man to have at your side!

No one friction material can possibly handle all motion control needs. That explains the wide latitude the J-M product line offers you when it's time to select frictions to suit *your* design.

Johns-Manville has developed a range of frictions to meet almost any requirement. Each piece can be depended on to give the sort of performance expected in well-designed equipment. And experienced J-M Representatives and extensive J-M research facilities are ready to help you select the most effective and economical material. Where miniaturization is a factor . . . in wet or dry operations . . . J-M Frictions can be ordered as small, integrally molded precision parts. J-M Small Molded Parts can also be compounded for anti-friction needs such as rotary seals, bushings or bearings. Now—before you get to work on that new design—is a good time to consult your J-M Friction Specialist.

For your free copy of the J-M Industrial Friction Materials Guide, giving recommendations, design and operational data on all J-M friction types and styles, write Johns-Manville, Box 14, New York 16, N.Y. In Canada: Port Credit, Ontario. Ask for FM-35A.

JOHNS-MANVILLE

JOHNS-MANVILLE JM PRODUCTS

Circle 487 on Page 19

ANOTHER IN A SERIES
OF MOTOR FACTS
FROM ALL INDUSTRIES

"Roughest duty we have ever seen motors endure"

reports Marquette Iron Mining Co. of the Westinghouse Life-Line "A" motors in its Eagle Mills Pelletizing Plant

Operating continuously, 24 hours per day, dependable Westinghouse Life-Line® "A" motors drive a network of fans and conveyors at the Eagle Mills Pelletizing Plant of Marquette Iron Mining Co., Ishpeming, Michigan.

Some of these motors are located directly above a sintering machine where ambient temperatures often exceed 200° F and the motor is subjected to deposits of finely divided iron ore. Under these conditions, not a single motor breakdown or failure has occurred during 11 months of service.

Says Mr. Ed Gagnon, plant electrician, "Our Westinghouse motors have given us complete reliability on the roughest tests we have ever seen a motor endure."

For specific information about the ways your operation can benefit from the improved performance, longer life and reduced maintenance offered by the dependable Life-Line "A," contact your nearby Westinghouse sales engineer. Or write to Westinghouse Electric Corporation, P.O. Box 868, 3 Gateway Center, Pittsburgh 30, Pennsylvania. J-22077

YOU CAN BE SURE...IF IT'S Westinghouse

Deposits of powdered iron ore are no problem to this 2-hp Life-Line "A" motor driving conveyor which carries powdered iron ore to the balling disc where ½" pellets are formed. Presealed, prelubricated Life-Line "A" bearings keep dirt and other material out.

Circle 488 on Page 19

The big advantages of Taper-Lock mounting are now available for practically all of your sprocket installations. Below is listed the new wide range of types and sizes offered by Dodge!

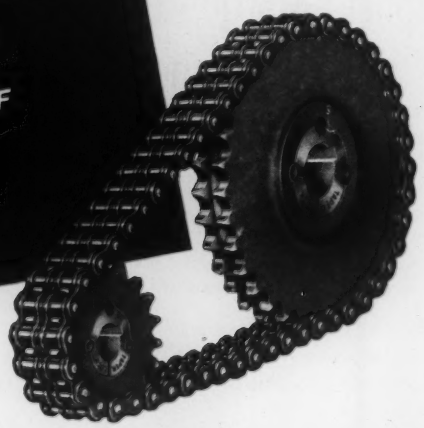
This important expansion of the Dodge line is the result of the enormous popularity of the Taper-Lock idea. Taper-Lock Sprockets are *modern*. Industry likes them because they go straight from shelf to shaft without machining—saving time. They are "easy on—easy off"—saving work. Their bushings can be re-used, not only in replacement sprockets, but in sprockets of different sizes and also in Taper-Lock Sheaves, Couplings, Conveyor Pulleys. Taper-Lock saves inventory—and money!

Dodge Taper-Lock Sprockets and Dodge Roller Chain are available through your local Dodge Distributor. Call him. Or write us for bulletin.

TAPER-LOCK®

ROLLER CHAIN DRIVES ARE NOW AVAILABLE IN A NEW WIDE RANGE OF TYPES AND SIZES

No Reboring!
No Keyseating!
No Waiting!



DODGE
of Mishawaka, Ind.

CALL THE TRANSMISSIONEER — your local Dodge Distributor. Factory trained by Dodge, he can give you valuable help on new, cost-saving methods. Look in the *white* pages of your telephone directory for "Dodge Transmissioneer."

- ***DOUBLE PITCH CHAIN and SPROCKETS***
  Transmission Series (No. 2040 to 2080) and Conveyor Series (No. 2040 to 2100). Sprockets to 112 teeth—including, for the first time, stock sprockets of 17, 19, 21, 23, 25 and 35 teeth *made especially for double pitch chain*. Introduced by Dodge, these sprockets are designed for even distribution of tooth engagement and absolute accuracy of mesh. Wear is reduced by half. Life of chain and sprocket is doubled!
- ***PLATE SPROCKETS***
  Steel Plate, Type A. No. 35 to 120. Mandrel bore, bored-to-size or Taper-Lock.
- ***SINGLE STRAND CHAIN and SPROCKETS***
  No. 35 to 160. Sprockets to 112 teeth.
- ***DOUBLE STRAND CHAIN and SPROCKETS***
  No. 35-2 to 80-2. Sprockets to 112 teeth.
- ***STANDARD ATTACHMENTS***

ALL TO ASA STANDARDS

DODGE MANUFACTURING CORPORATION, 3300 Union Street, Mishawaka, Indiana

DYNAMIC DIFFERENCE

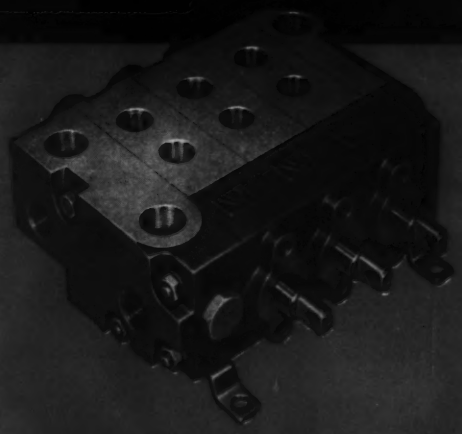
in hydraulic performance

Webster

DIRECTIONAL CONTROL VALVES

Combines to culvert cleaners — anywhere one, two or more hydraulic applications are handled at one time... *the difference is dynamically apparent when Webster is on the job!* Versatile! Parallel design permits control of up to 6 independent circuits. Range! Operating pressures to 2000 psi — shock pressures to 5000 psi. Lowest back pressure. Compact! Smallest size for rating. Three sizes — single spool type in 20 gpm capacity, parallel stacked in 20 and 40 gpm capacities.

You find Webster Directional Control Valves on leading agricultural, road building and industrial machines. Chances are there's a size and model ideally suited for your product — for the dynamic difference that pays!



DESIGNED FOR PEAK PERFORMANCE

- Alloy steel spools — heat-treated, precision-ground.
- Fully balanced at all pressures.
- Stack valves have throttling grooves in spools for smooth, gradual flow.
- Inlet and outlet connections can be made to the same end of the valve assembly to simplify hook up.
- Alternate porting positions provided for flexibility in application.

Call the man from Webster

... he's one of a staff of engineers, specially trained in hydraulic application. He can help you solve special problems when hydraulics become a part of your design!

OIL HYDRAULICS DIVISION

WEBSTER ELECTRIC

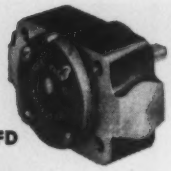
RACINE · WIS

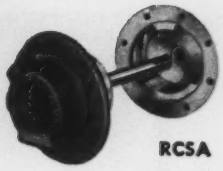
our 50th year

Circle 490 on Page 19

POWERMITE

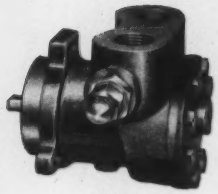
RCK


LFD


RCSA

For your pump problems . . . over 800 different TUTHILL pumps

SERIES 42


LPFV

- **Capacities to 200 GPM: pressures to 1500 PSI**
- **For lubrication, coolant, oil burning, circulating, and hydraulic applications**

For over 30 years the Tuthill Pump Company has been meeting the pump needs of American industry. In literally thousands of demanding applications . . . in lubrication, hydraulics, oil transfer and a wide variety of other services . . . Tuthill pumps are providing the dependable, trouble-free performance which has made them an industry standard.

With over 800 different models Tuthill provides a wide selection. Skilled application engineers, especially trained to "fit the pump to the problem", provide valuable design assistance in precisely meeting your pump requirements.

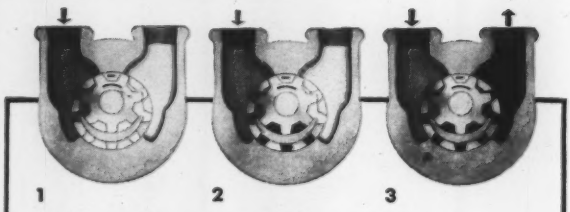
Most Tuthill units employ the time-tested internal gear operating principles described at the right. The complete Tuthill line also includes internal spur gear and sliding vane models.

Many options and modifications

Tuthill pumps can be furnished to fit the requirements of your particular application. For example they can be supplied:

- With or without built-in relief valve
- With automatic reversing feature where pump must be driven from a reversing shaft . . . or a machine must be shipped without knowing ultimate direction of driving unit
- As stripped models to be built into your equipment
- With a wide variety of porting arrangements
- With special shaft seals for various applications
- With provisions for steam jacketing
- With many shaft modifications for drive connections

In short, if your specifications lie within 200 GPM capacity, pressures to 1500 PSI, and speeds to 3600 RPM, Tuthill probably has the answer.



Internal gear pumping principle

In Tuthill internal gear pumps there are only two moving parts. The principle is based on the use of a rotor, idler gear and a crescent shape partition cast integral with the cover.

Power applied to the rotor is transmitted to the idler gear with which it meshes. The space between the outside diameter of the idler and the outside diameter of the rotor is sealed by the crescent. As the pump starts the teeth come out of mesh increasing the volume. This creates a partial vacuum, drawing the liquid into the pump through the suction port (Fig. 1). The liquid fills the spaces between the teeth of the idler and the rotor and is carried past the crescent partition through the pressure side of the pump (Fig. 2). When the teeth mesh on the pressure side the liquid is forced from the spaces and out through the discharge port (Fig. 3).

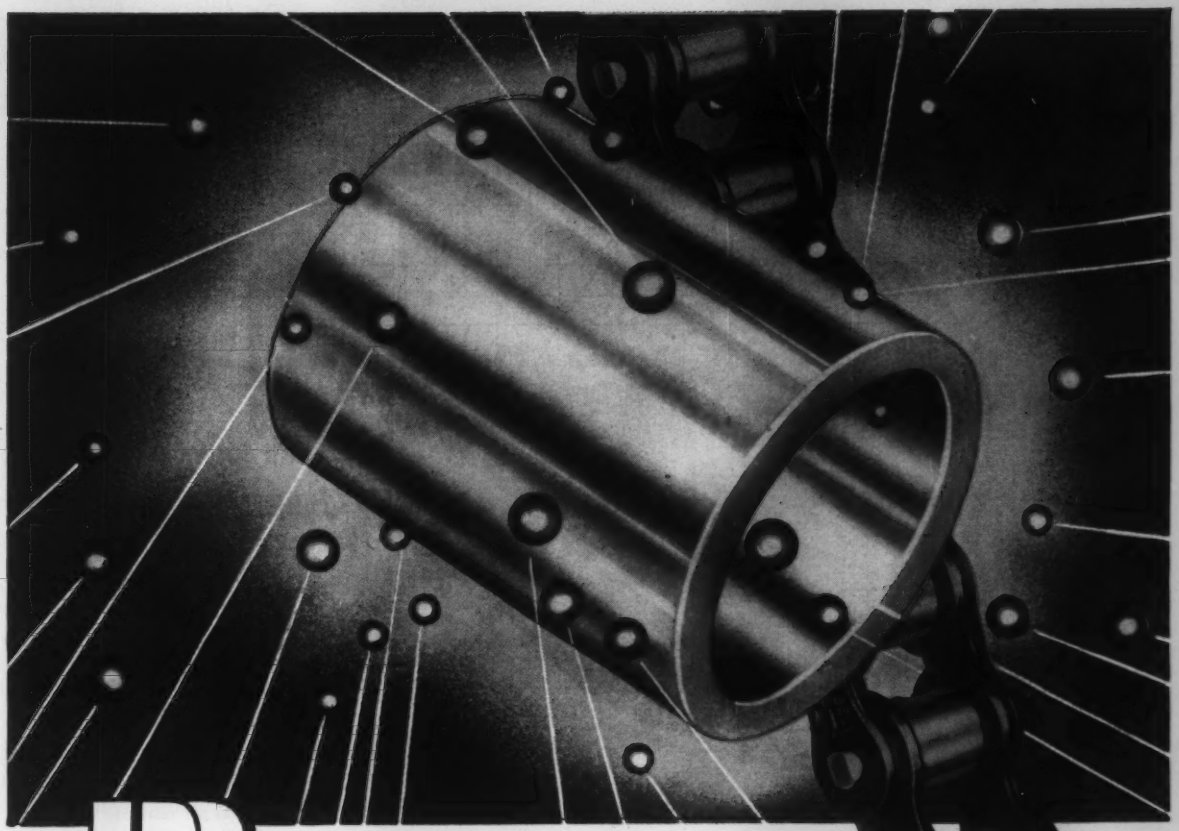
Write today for catalogue 100. Or better yet, ask that a Tuthill Application Engineer call to discuss your specific pumping problem.

Tuthill manufactures a complete line of positive displacement rotary pumps in capacities from 1 to 200 GPM; for pressures to 1500 PSI; speeds to 3600 RPM.

TUTHILL PUMP COMPANY

953 East 95th Street, Chicago 19, Illinois

Circle 491 on Page 19



Rollers
fortified against fatigue

Shot-peening "cold-works" extra fatigue life into LINK-BELT roller chain

Shot-peening gives rollers of Link-Belt precision steel roller chain exceptional strength and stamina. And after shot-peening, they are burnished rather than ground or sanded. This achieves a SILVER-BRITE finish—and more important, *retains the fatigue resistant qualities of shot-peening.*

Other long-life "extras" of Link-Belt roller chain include: close heat-treat control, lock-type bushings, pre-stressing, pitch-hole preparation. For details, see Book 2657.

LONG LIFE AHEAD! Rollers for Link-Belt precision steel roller chain tumble out of shot-peening machine after being cold-worked to withstand punishment of today's high-speeds and heavy loads.

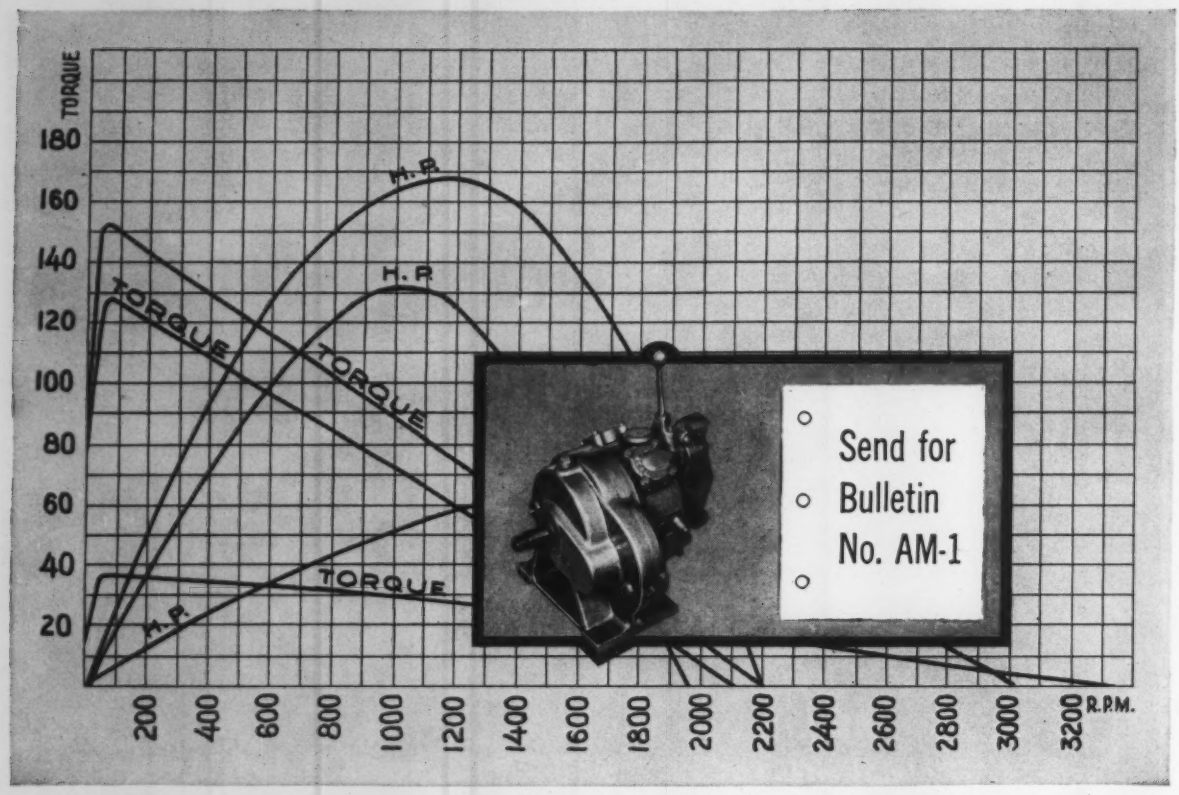
LINK-BELT

ROLLER CHAINS AND SPROCKETS

LINK-BELT COMPANY: Executive Offices, Prudential Plaza, Chicago 1. To Serve Industry There Are Link-Belt Plants, Sales Offices and Stock Carrying Distributors in All Principal Cities. Export Office, New York 7; Australia, Marrickville (Sydney); Brazil, Sao Paulo; Canada, Scarboro (Toronto 13); South Africa, Springs. Representatives Throughout the World. 15,082

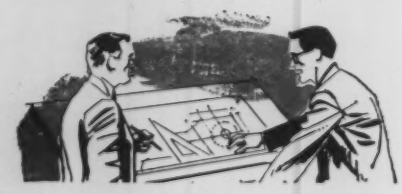
BOOK 2657 has 154 pages of roller chain data. For your copy, contact your nearest Link-Belt office. (See CHAINS in the yellow pages of your phone book.)

Circle 492 on Page 19



Typical torque and horsepower curves for three sizes of Gardner-Denver 5-cylinder radial air motors.

Power curve proves high starting torque of this radial air motor



IN INDUSTRY—SPEEDING THE PACE,

the Gardner-Denver specialist is an integral part of the team. He works side by side with engineers and designers, helping to solve their problems, for at Gardner-Denver there's no substitute for men—our 100-year philosophy of growth.

Here's a compact *air* power package that develops high starting torque and maintains smooth power under all speed and load conditions. Gardner-Denver's 5-cylinder radial design provides accurate counterbalancing and overlapping power impulses. At least two cylinders are always on the power stroke and three during part of the cycle. Heavy loads start easily . . . accelerate smoothly.

This Gardner-Denver air motor also offers control flexibility, vibrationless operation, high torque at any speed, freedom from overload damage and spark-free operation.

There are six Gardner-Denver radial air motors from which to choose, with power and speeds for a wide variety of applications. Sizes from 2 to 16 hp. Direct drive or built-in gear reduction. Reversible and non-reversible models. Put air power to work in your design. Contact your nearby Gardner-Denver representative for complete information.

GARDNER-DENVER Since 1859

100 1959 YEARS

EQUIPMENT TODAY FOR THE CHALLENGE OF TOMORROW

GARDNER - DENVER

Gardner-Denver Company, Quincy, Illinois

In Canada: Gardner-Denver Company (Canada), Ltd., 14 Curity Avenue, Toronto 16, Ontario

Circle 493 on Page 19

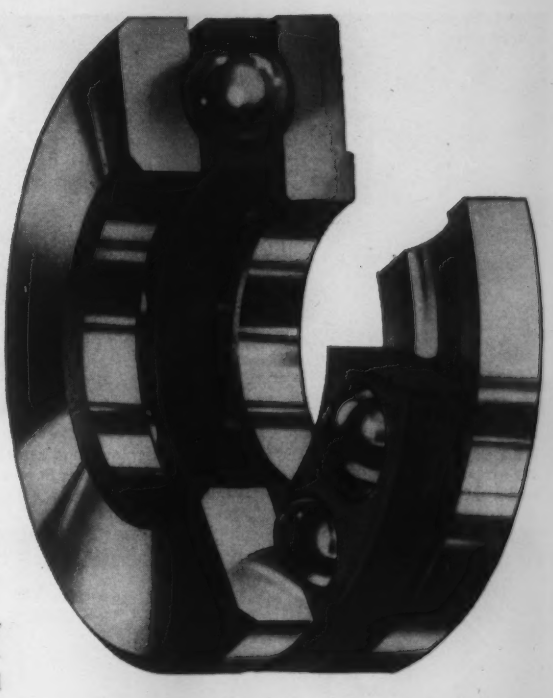
Aetna Bearing

PRECISION

begins with Rigid Steel Specification—

Laboratory Analysis—

and Controlled Heat Treatment



Each shipment of every grade of steel is chemically analyzed and tested for conformity to specifications – then laboratory tested for hardenability, cleanliness and grain structure before acceptance.

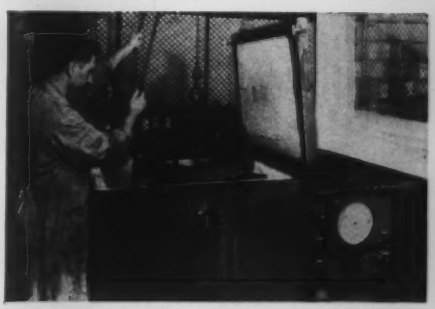
Heat Treatment then gives the exact degree of hardness for full bearing load capacity and long service life . . but hardness must be controlled—over hardening imparts brittleness to steel; under hardening reduces life and load capacity. Every piece of Aetna hardening equipment is therefore controlled automatically by recording type electrical instrumentation which provides absolute accuracy in both temperature and time of the heat treating cycle.

Sub-zero Cold Treatment is used for bearing steels requiring extremely close tolerance to permanently stabilize the structure, and effect the ultimate in fatigue resistance and reliability.

The result of these exacting treatments is available in Aetna Bearings which are capable of taking and maintaining the exceedingly fine finishes which secure true anti-friction performance. *You have a better operating product when it is equipped with Aetna Bearings.*

Precision Parts held to the same exacting standards, produced in quantity at low cost to your exact specifications. Size to 38" O.D. Submit blueprints, quantities and delivery for quotation.

Unloading a heat from one of a battery of carburizing furnaces.



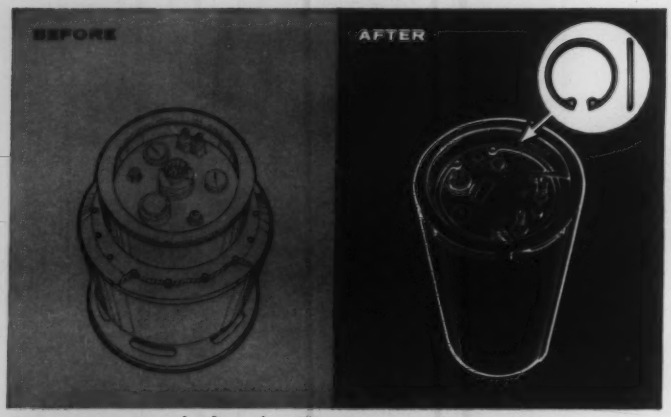
Heavy duty ball race receiving minus 150° F. cold treatment to completely transform steel structure to tougher, more stable martensite.

AETNA BALL AND ROLLER BEARING COMPANY

Aetna

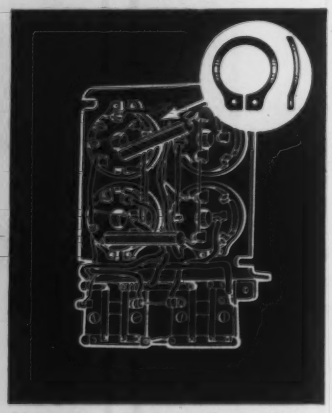
DIVISION OF PARKERSBURG-AETNA CORPORATION • 4600 SCHUBERT AVE. • CHICAGO 39, ILL.

ANTI-FRICTION SUPPLIERS TO LEADING ORIGINAL EQUIPMENT MANUFACTURERS SINCE 1916

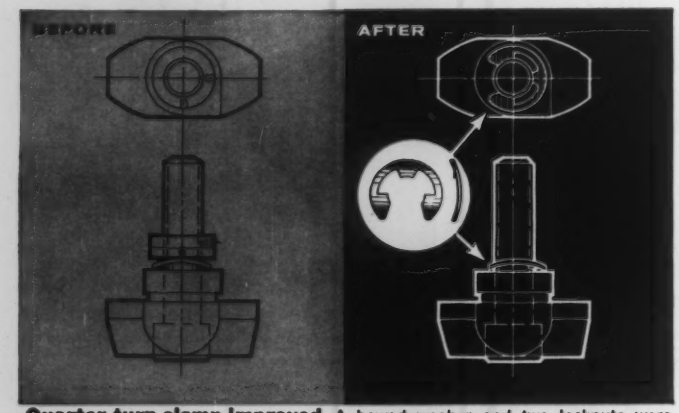


Pressure cover design simplified. Two axially assembled Truarc Series 5002 beveled rings eliminate 27 bolts, reduce machining and assembly time from 78 to 1½ hours and make possible drastic size and weight reductions. Rings retain two covers of a pressurized x-ray unit. **Savings: about $500 per unit.**

Parts eliminated in slide assembly. Two radially assembled Truarc Series 5139 Prong-Lock® Rings provide proper spring tension, eliminate looseness and wobble in this office calculator shift-slide. Original design called for a cut washer, spring washer, and cotter pin—all eliminated.



New way to install electron-tube sockets. Easy-to-apply Truarc Series 5101 bowed external rings lock tube sockets to chassis plate in this assembly. Bowed construction takes up tolerances of molded grooves, thickness of base. Individual sockets are removable for field service.



Quarter-turn clamp improved. A bowed washer and two locknuts were eliminated in this quarter-turn jig-and-fixture clamp by a Truarc Series 5131 bowed E-ring. The radially assembled ring holds the screw captive, provides required rotational drag between parts with sufficient tension to insure tight fit when the screw is first engaged. **Typical savings: $1.35/unit—assembly up 70%.**

Truarc rings for end-play take-up offer significant design advantages

A number of Truarc retaining rings are available to take up end-play or loose fit caused by accumulated tolerances and wear. The rings often eliminate spring washers, collars and set screws, nuts, bolts, rivets, cotter pins and other conventional fastening devices with outstanding cost savings in machining and assembly time.

Truarc retaining rings designed to deal with the end-play problem are of two general types: **bowed rings** for resilient end-play take-up and **beveled rings** for rigid end-play take-up.

Bowed retaining rings are widely used for preloading bearings, preventing vibration or oscillation in linkages, providing tension on adjusting screws. Of particular interest is the radially installed Truarc Prong-Lock® ring which locks securely to the shaft by means of two prongs. It provides exceptional thrust load capacity, may be used as a shoulder against rotating parts, and often eliminates springs, bowed washers and other tensioning devices.

In beveled rings for rigid end-play take-up, the groove-engaging edge is beveled at 15°. There is a corresponding bevel on the load-bearing groove wall. To take up end-play, the ring acts as a wedge between the outer groove wall and the part being retained.

These are just a few of the 50 functionally different types of Truarc retaining rings. They come in up to 97 standard sizes, six metal specifications, 13 different finishes. The entire line as well as accessory assembly tools, grooving tools, and over 70 typical applications are shown in the new catalog RR 10-58. Write for your copy today. And remember Waldes Truarc engineers are always ready to work with you on your specific projects. Waldes Kohinoor, Inc., 47-16 Austel Place, Long Island City 1, N.Y.

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WALDES
TRUARC®
RETAINING RINGS
Waldes Kohinoor, Inc., Long Island City 1, N.Y.

TRUARC RETAINING RINGS...THE ENGINEERED FASTENING METHOD FOR REDUCING MATERIAL, MACHINING AND ASSEMBLY COSTS

KOHLER ENGINES

4-cycle • Short Stroke Air-cooled

Kohler engines are conservatively rated, quick-starting, reliable.

Experienced application engineers will help you choose a Kohler engine to do your job.

Kohler Co. has manufactured internal combustion engines for 38 years.

MODEL
K161

MODEL
K662

Riding Tractors
Rotary Tillers • Orchard Sprayers
Centrifugal Pumps • Weed Cutters
Highway Line Markers • Conveyors
Riding Lawn Mowers • Turf Aerators
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Lawn Rollers • Cultivators • Grain Blowers • Milkers • Grain Elevators
Disc Grinders • Pump Jacks • Portable Saws • Sprayers • Motor Bikes
Hoists • Floor Sweepers • Augers • Air Compressors
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Sand Spreaders • Spike Pullers • Tie Tampers
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Enameled Iron and Vitreous China Plumbing Fixtures • Brass Fittings • Electric Plants • Air-cooled Engines • Precision Controls

Circle 496 on Page 19

SMOOTH, "CUSHION" START

with new Century Electric part-winding start motor

This new motor . . . at either 1200 or 1800 rpm's . . . will give you smooth, "cushion" acceleration. No cogging, jerking or jarring equipment. No sub-synchronous stalling. Just dependable torque with the same 40% reduction in starting current of all Century Electric part-winding motors.

New winding—A special winding scheme makes this extra smooth start possible. Special cross connections are made between coil groups of the basic motor winding. Result: balanced stator field on first step position . . . no cogging . . . smooth acceleration. Means that now motors will give better performance on part-winding start. Also, more time can be taken for acceleration because the winding does not go "across the line" until the rotor has reached a higher speed.

Applications—Have an application where power company restrictions limit in-rush current? The complete line of Century Electric part-winding start motors is the answer. They provide the most economical and dependable way of starting equipment with low-starting torque such as fans, blowers, centrifugal pumps, and compressors, as well as reciprocating compressors equipped with unloading valves. And with new Century Electric part-winding motors heavier loads than ever before can now be brought smoothly up to speed.

Construction—Century Electric part-winding start motors are available in approximate range of 20 to 150 hp sizes and in speeds of 1200 and 1800 rpm. They all have the high quality construction features of all Century Electric squirrel cage induction motors . . . coils are insulated with tough polyvinyl acetal resin . . . windings are dipped and baked with several coats of high temperature synthetic varnish which protect against oil fumes, mild acids and dust and grit . . . rotors are dynamically balanced so that motors run with extreme quietness and smoothness . . . rugged cast iron frame construction assures long life and low noise level.

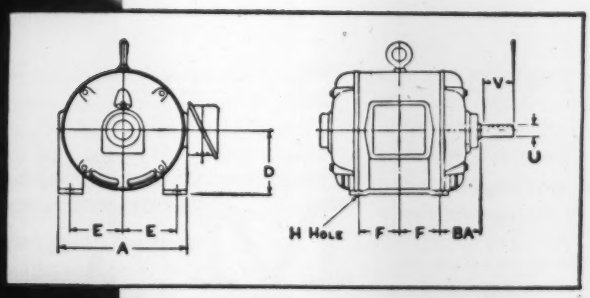
Application aid—A Century Electric application engineer will be glad to discuss your part-winding start problems with you. Century Electric also makes a complete line of motors . . . all sizes and types from 1/20 to 400 hp. For a copy of the new Century Electric Motor Application Guide, please write for bulletin 270A.

CENTURY ELECTRIC COMPANY

St. Louis 3, Missouri *Offices and Stock Points in Principal Cities*

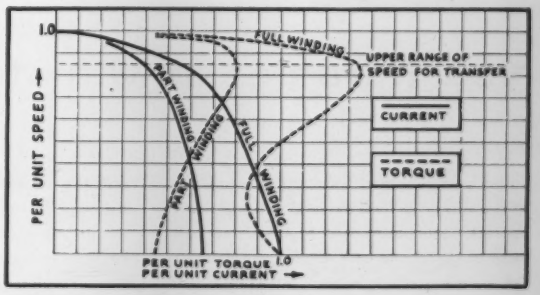
Century

59-10



TYPICAL 30 HP part-winding start motor dimensions

Frame Size	Key	A	BA	D	E	F	H	U	V
SC 326U	½ x ½	16	5¼	8	6¼	6	21/32	1⅛	5⅛



SPEED-TORQUE curves show how transfer to full winding can be made at higher speed after current has fallen off.

Circle 497 on Page 19

Nature's Tiny Flashlight. There's more to the surprisingly bright flashes of the firefly (*Lampridae*) than the body chemicals which it burns. In addition, a clear, curved section of the insect's skin acts as a magnifying lens and a layer of crystals as a reflector.

Miniature Angle Counter. Moving tape on this counter used in aircraft (approx. 3½″ long) shows horizontal angular deviation from pre-set point. MPB bearings on key shafts help keep torque at approximately 0.1 ounce-inch at temperatures from −55°C to +125°C.

Man with Miracles. Chuck Sheridan is constantly helping industry and aviation to solve problems of friction and inertia with MPB bearings. Like all MPB Technical Representatives, he'll be glad to help you meet the challenge of miniaturization efficiently and economically.

New Miracles in Miniaturization

ACTUAL SIZES OF BEARINGS USED IN ANGLE COUNTER SHOWN ABOVE

Today's accelerated processing programs (and space programs) demand that equipment operate continuously and faultlessly at high rates of speed and with maximum efficiency. The bearings which minimize frictional and inertial losses in such equipment must often be extremely small, but nonetheless dependable in every respect. MPB supplies industry and the military with tiny, tough, reliable bearings from a line of 500 types and sizes ranging down to 1/10″ O.D. "Specials" when necessary. For complete details, ask for our new catalog. Engineering assistance on request. Write **Miniature Precision Bearings, Inc.,** 111 Precision Park, Keene, N. H.

MINIATURE PRECISION

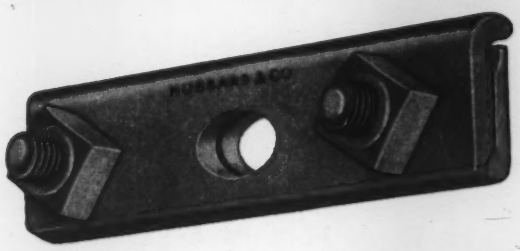
MPB

BEARINGS, INC.

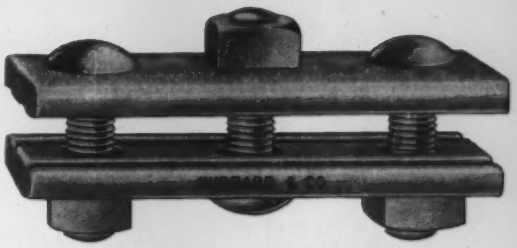
Helps you perform miracles in miniaturization

Circle 498 on Page 19

STEEL SHAPED TO CUT COSTS AND IMPROVE PRODUCTS



One automatic operation punches three holes and shears off the part from a USS Hot-Rolled Special Section. No machining necessary.



Hubbard pole line hardware made from USS Special Sections.

Pole line hardware • one punch • made from USS Special Sections

Hubbard and Company is one of the largest pole line hardware manufacturers in this country. They turn out guy clamps, cable suspension clamps and lashing clamps by the thousands. To keep production costs low, they use USS Special Sections already rolled to the proper cross section for the finished piece.

Many items can be punched and sheared in one automatic operation so that there is no machining and very little scrap. Parts can then be galvanized, bolts inserted and the job completed.

How USS Special Sections can reduce your costs. If you have an irregular steel part that must be produced in quantity at low cost, let us check your drawings. Many times a complex and costly assembly can be replaced by the use of one USS Hot-Rolled Special Section. Designs are unlimited. Write for our new book showing many intricate shapes already being produced. United States Steel, 525 William Penn Place, Pittsburgh 30, Pa.

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USS

United States Steel Corporation—Pittsburgh
Columbia-Geneva Steel—San Francisco
Tennessee Coal & Iron—Fairfield, Alabama
United States Steel Export Company

United States Steel

Please direct inquiries to advertiser, mentioning MACHINE DESIGN

. . . . . What's the limit: Heat? Shock? Speed? Or complicated radial and thrust loads?

Name the combination of requirements . . . and chances are you'll find them met by a Rollway Maximum precision radial cylindrical roller bearing. If not, then Rollway engineers will modify any factor to meet your application.

Rollers are crowned to prevent end-loading and the resultant spalling of races. Directional trueness is maintained by retainers of standard bronze or "Rollube" ferrous alloy of one piece or two piece construction.

You may wish to refer to the Rollway Catalog and Engineering Data Book when writing specifications for a high precision bearing. It contains the first listing, by any manufacturer, of the thrust capacities of cylindrical radial roller bearings. Send for it today.

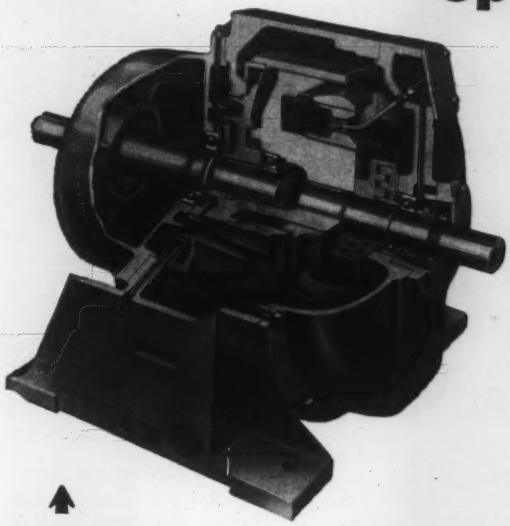
ENGINEERING OFFICES:

Syracuse Boston Chicago Detroit
Toronto Pittsburgh Cleveland
Seattle Houston Philadelphia
Los Angeles San Francisco

ROLLWAY®
BEARINGS
COMPLETE LINE OF RADIAL AND THRUST CYLINDRICAL ROLLER BEARINGS

Circle 499 on Page 19

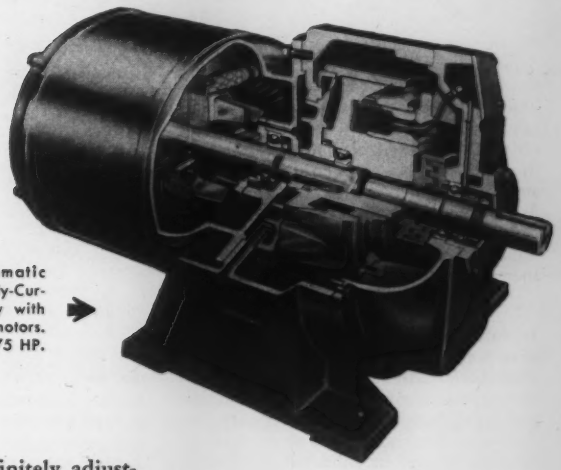
The BEST Solution to Difficult Speed Control Problems—



Dynamatic Liquid-Cooled Couplings provide infinitely adjustable speeds for nearly every application from 3 to 75 HP. Note the absence of slip rings, brushes, and commutators. Heavy-duty types with capacities up to 5,000 HP are also available.

EATON DYNAMATIC®

LIQUID-COOLED EDDY-CURRENT COUPLINGS and DRIVES



"Dynaspede" Drives are Dynamatic Liquid-Cooled, Stationary-Field Eddy-Current Couplings mounted integrally with standard, D-flange, squirrel cage motors. Available in capacities from 3 to 75 HP.

Here's Why—

Dynamatic Liquid-Cooled Couplings and Drives provide infinitely adjustable speed from a constant speed source—or constant speed from a variable speed source. They operate on standard alternating current. Rotary power is transmitted through the coupling by an electromagnetic reaction between the driving and driven members of the unit—there is no mechanical contact of rotating members to cause wear and require adjustment or replacement.

A wide range of standard and special control features may be obtained from a remotely-mounted electronic control system. Infinite speed adjustment, constant speed control, on-off clutch control, torque limit, acceleration control, inching, and threading are a few of the many functions available. The addition of an eddy-current brake to standard couplings or drives provides smooth, cushioned stops and controlled deceleration.

Liquid-Cooled Dynamatic Couplings and Drives deliver more horsepower than other types of the same physical size, thus conserving space in a busy machine area. Efficient heat dissipation permits continued operation at low speeds, or stall with full load.

Completely enclosed, Dynamatic liquid-cooled units are protected from dust, dirt, and other atmospheric impurities. Dynamatic design involves no brushes or slip rings; there is no possibility of arcing. With simple modification these units can be made explosion-resistant for hazardous applications.

Infinitely Adjustable Speeds from AC Power

★

Full-Torque Starts

★

Wide Range of Control Functions

★

No Slip Rings, Brushes or Commutators

★

Completely Enclosed Design

★

Low-Cost Maintenance

Send for Our New Illustrated Bulletin.

EATON

DYNAMATIC DIVISION
MANUFACTURING COMPANY
3307 FOURTEENTH AVENUE • KENOSHA, WISCONSIN

Circle 500 on Page 19

#5 HONEYCOMB AS AN ENERGY ABSORBER

While honeycomb materials are used principally in light-weight, high-strength sandwich structures, increasing emphasis has been placed on the use of honeycomb to control forces exerted on decelerating objects. Such control is highly desirable in cushioning the impact of air-dropped supplies, protecting instrumented missile assemblies, providing impact-limiting linkages in landing gear structures, packaging fragile items, and protecting human occupants of high speed vehicles.

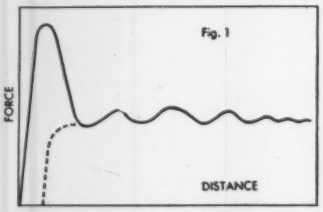
The Problem

Instances requiring impact energy absorption are generally typified by low tolerable deceleration rates for the structure or its contents, high impact velocities, and small maximum allowable stopping distances. Such absorbers as mechanical springs, sponge or solid rubber, foams, cork, and wadding generally exhibit spring characteristics, in that the force transmitted through these absorbers to the object being stopped increases continuously through the distance in which the absorbers contract. In addition, many of these materials do not absorb energy, but merely store it for release as rebound energy.

If an absorber could exert a relatively constant non-rebound force throughout the entire stopping distance, that distance could be shortened, or alternately, the maximum force acting on the object in the same stopping distance could be materially reduced.

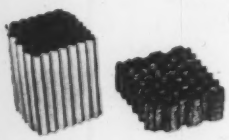
Advantages of Honeycomb

Honeycomb core materials tend to follow such a constant force curve, as shown in Figure 1.



The initial peak on the curve represents the point at which compressive failure begins. This peak can be lowered by prestressing the core to produce slight initial compressive failure. When subjected to further or subsequent loading, the prestressed core proceeds immediately to carry the crushing load, as shown by the dashed line curve in Figure 1.

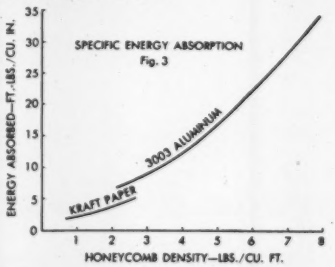
Figure 2 illustrates the appearance of aluminum honeycomb core before and after compressive failure.



By designing a honeycomb core assembly with a specified cell depth this constant force can be applied over a predetermined stopping distance.

Available Materials

These principles apply to aluminum and paper honeycomb, and most similar honeycomb core materials fabricated from ductile metals and fabrics. Figure 3 indicates the general range of energy absorption capacity available in aluminum and paper materials.



These capacities can be further increased by filling the cells with various foamed materials.

Optimum Solution

The choice of materials by the designer will depend upon the particular requirements of the application. But it seems apparent that the utilization of honeycomb offers the optimum solution—in terms of weight and volumetric efficiency—to many types of energy absorption problems.

Others in This Series. Copies sent on request

1. **Honeycomb Sandwich Panels**
2. **Honeycomb Sandwich Materials**
3. **Successful Honeycomb Sandwich Design**
4. **Honeycomb Design Characteristics**

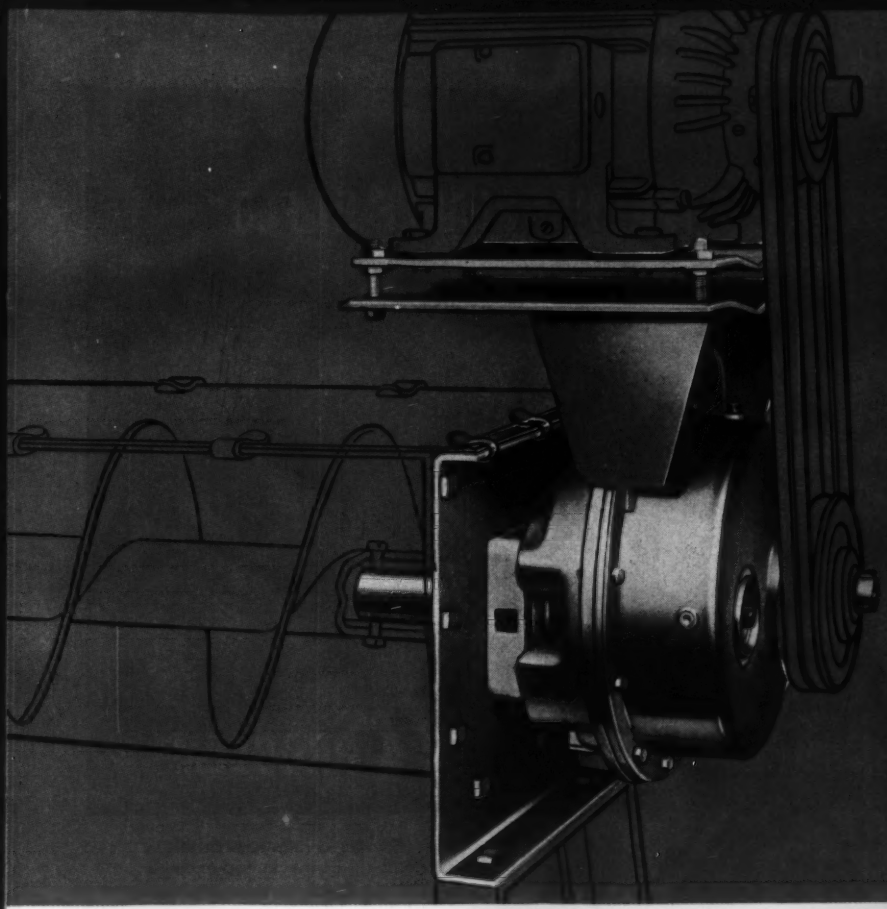
INFORMATION REQUEST

Send to Hexcel Products Inc. Dept. 57
2332 Fourth Street, Berkeley 10, California.

NAME_____
TITLE_____
COMPANY_____
STREET_____
CITY_____ ZONE____ STATE_____

HEXCEL® PRODUCTS INC.
World leader in honeycomb
Executive Offices: 2332 Fourth Street, Berkeley 10, Calif.
Plants: Oakland and Berkeley, Calif.; Havre de Grace, Md.
Sales Offices: Long Island City, N.Y.; Fort Worth, Texas; Inglewood, Calif.

Circle 501 on Page 19



NEW! FALK Screw Conveyor Drive

U.S. and Foreign Patents Applied For

—the drive our customers asked for

Our customers helped us design this new unit. We sent our men into the field to find out what our customers needed in a screw conveyor drive—then our engineers designed a new drive that offers the maximum of service, versatility, operating economy and long life. Here are some of its outstanding features:

A COMPLETE DRIVE: Saves engineering and assembly time. Six sizes to cover entire range—each with these ratios: — 4:1, 9:1, 14:1 and 24:1. Bolts to any standard trough end—eliminates trough end bearing. Eliminates drive shaft wobble. Efficient FALK single helical gears.

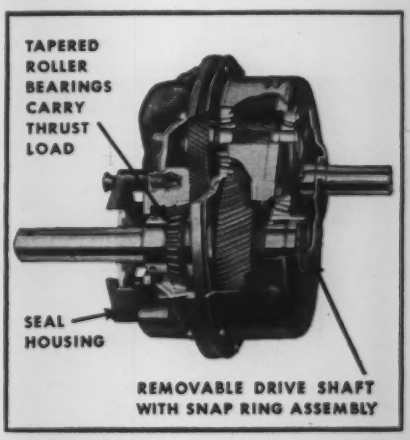
SEAL HOUSINGS: Choice of seals (neoprene or leather lip, felt or waste) to accommodate material conveyed. Space between trough seal and unit seal prevents conveyed material from reaching unit seal.

REMOVABLE DRIVE SHAFT: Snap ring assembly permits easy removal. Five sizes, from 1½" to 3 7/16".

TROUGH END: Can be fastened to any standard trough. Eight sizes, from 6" to 20".

ALL-STEEL MOTOR MOUNT: Saves costly engineering and installation time and costs; no motor plates to design or fabricate. Motor can be mounted in virtually any position. Pre-drilled to accommodate NEMA standard motors ½ to 30 HP.

AN IMPORTANT ECONOMY: Buy only what you need—the basic reducer alone, or with trough end and/or motor mount. For detailed information, contact your Falk Representative or Distributor—or ***write direct for Bulletin 7106.***



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MANUFACTURERS OF QUALITY GEAR DRIVES AND FLEXIBLE SHAFT COUPLINGS

Representatives and Distributors in most principal cities

Circle 502 on Page 19

FALK

...a good name in industry

NEW!

SCHRADER INDUSTRY-INTERCHANGEABLE HI-FLO* AIRLINE COUPLER!

SAFE PUSH-PULL OPERATION
ACCIDENTAL UNCOUPLING NO LONGER A PROBLEM!

Schrader's new quick-acting couplers are full of features that afford the best air service. Safety's built in . . . it won't open accidentally even when dragged on the ground and snarled on a piece of machinery . . . yet the heavily knurled new coupler connects and disconnects in a single upstream push or pull with *one hand, gloved or greasy!*

More features: fastest air flow . . . non-corrosive . . . case hardened steel all through . . . meets and exceeds military specs . . . engineered for simple, easy replacement of parts in the field.

Important: Schrader's new coupler is interchangeable with others of similar type. A variety of end fitting styles are available. See your supplier soon.

NEW COUPLER CHECK UNITS AND ADAPTERS

#5139-12–¼ N.P., FEMALE

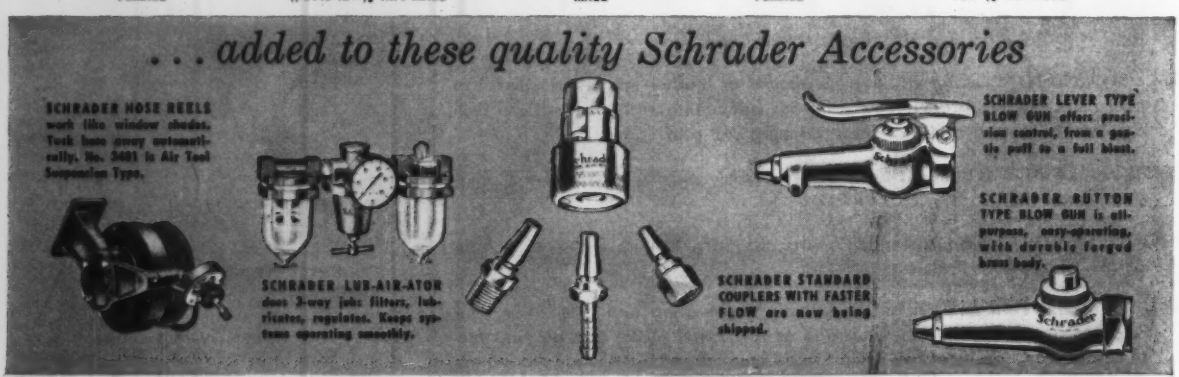
#5138-12–¼ N.P. MALE
#5140-12–⅜ N.P. MALE

#5138-11–¼ N.P. MALE

#5139-11–¼ N.P. FEMALE

#5140-11–SERRATED SHANK FOR ⅜ I.D. HOSE

. . . added to these quality Schrader Accessories



*Reg. U. S. Pat. Off.

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QUALITY AIR CONTROL PRODUCTS

Do you need pressurized air for jobs like these?

- Oil or Gas Furnace Blowing
- Cupola Blowing
- Gas Line Boosting
- Exhausting from Grinding Wheels

. . then this is what you need!

"BUFFALO" TYPE "E" BLOWERS AND EXHAUSTERS

Wherever you need constant air pressures up to 5500 cfm, these dependable "Buffalo" Blowers will do the job most efficiently and economically. Compact, ruggedly-built, direct-connected "Buffalo" Type "E" Blowers and Exhausters are available in eight sizes. Pressures up to 2 lbs. mean you can choose the units exactly suited to your needs.

Various special features are available, including flanged inlet, flanged outlet, stuffing box around the shaft for gas-tightness. For corrosive fume handling, housings can be coated with Bisonite or Heresite. Housings may also be cast of special metals. Stainless steel, Everdur, brass or aluminum wheels are available. Used in multiple, these units are more flexible and economical than a single large blower.

For full information on "Buffalo" Type "E" Blowers and Exhausters, contact your "Buffalo" engineering representative—or write us for Bulletin FMB-935. Other units suitable for higher pressures are the type RE and type CB blowers.

"Buffalo"

BUFFALO FORGE COMPANY
Buffalo, N. Y.
Buffalo Pumps Division, Buffalo, New York
Canadian Blower & Forge Co., Ltd., Kitchener, Ont.

VENTILATING • AIR CLEANING • AIR TEMPERING • INDUCED DRAFT • EXHAUSTING • FORCED DRAFT • COOLING • HEATING • PRESSURE BLOWING

Circle 504 on Page 19

Which self-locking fastener?

Lamson makes all three, helps you cut costs, not corners

Nylok. Lok-Thred. Place Bolt. All are variations on the same theme. However, one of the three will be better suited to your application. One will lower your assembly cost more than the other two. Which one?

Because Lamson makes all three self-locking fasteners . . . standards and specials . . . Lamson engineers are anxious (and able) to recommend the one that's best for you. That helps you make a better product. That helps you cut costs... not corners. Contact a Lamson Sales Engineer for details.

SEND FOR ENGINEERING DATA

Gentleman: Mail engineering data on Place Bolts ☐ Lok-Thred ☐ Nylok ☐

Have nearest Sales Engineer call for appointment ☐

Application we're considering is _____

_____

Name _____

Company _____

Street _____

City _____ State _____

LAMSON & SESSIONS

5000 TIEDEMAN ROAD • CLEVELAND 9, OHIO

Plants in Cleveland and Kent, Ohio • Chicago and Birmingham

Circle 505 on Page 19

MACHINE DESIGN
November 12, 1959

Do It Yourself?

MANY a business or professional man, whose job pays five to fifty dollars an hour, happily occupies his spare time fumbling at menial tasks for which competent help is available at a fraction of his own rate.

Such waste is justified on various grounds, such as mental relaxation, and the chronic unreliability of people offering so-called services.

"Do-it-yourself" has become an integral part of our American way of life. Many derive a sense of creativity which a typical executive job fails to supply. They return to the job refreshed and invigorated by the complete change of pace.

But do-it-yourself in this sense has no place within an engineering department. The engineer who spends much of his time on two or three-dollar-an-hour routine jobs shouldn't expect to be paid at double that rate.

Management and engineers themselves share the responsibility of insuring the proper utilization of professional talents.

Management can provide the facilities and the trained help to relieve engineers of specialized tasks. An excellent example is the technical information service described by Tom Sainsbury in his article overleaf.

Engineers, if they wish to improve their status, must be willing to relinquish some activities—such as literature searching—no matter how intriguing the appeal to the intellect.

Colin Carmichael
EDITOR

WANTED: A flexible, efficient system for finding, distributing, and filing technical information needed on the job by engineers.

TECHNICAL

THOMAS R. SAINSBURY*

KEEPING up with the mounting tide of technical information and developments is a problem of growing concern in most engineering organizations. It takes on staggering proportions in companies with diversified product lines and interests.

At American Machine & Foundry Co., this problem reached the critical stage about three years ago. The answer: A technical information department staffed by specialists in information research. In performing its function as an information service,

AMF's Technical

What it does . . .

- Keeps up-to-date on available technical literature pertinent to present and future company activities
- Conducts product and literature searches
- Collects and distributes information on new products, processes, equipment, methods, and materials

Here's how one company found the answer with a

INFORMATION SERVICE

Manager, Drafting Processes, American Machine & Foundry Co., Stamford, Conn.

the newly formed group had two goals: 1. To minimize loss of productive engineering time spent in routine information studies. 2. To prevent duplication of the work of others in engineering problem areas.

Today, this operation is a recognized success. Its principles and concepts, which have been tested and proved in an organization with widely varying information requirements, may well hold the answer to similar problems faced by other companies, both large and small.

Information Department

Results . . .

- Increased use of information specialists to dig out technical literature, freeing engineers and other technical personnel for more productive work
- Complete, professional information studies without loss of productive engineering time
- Better knowledge of advances in technology and hardware

Staff and Services

At AMF, the Technical Information Dept. is part of the organization under the Vice President for Research and Development, Fig. 1. As such, it enjoys corporate status. All of its services are rendered without charge to any division, laboratory, or subsidiary within the over-all AMF organization.

This arrangement has a significant advantage. Engineers and other technical personnel working on funded projects can get professional literature or product searches without cost or without loss of productive time on the job.

The department staff, which started with only a manager and part-time clerical help, now also includes a technical analyst, a technical clerk, and a secretary. The following services are rendered:

1. Product searches, literature searches, and bibliographies.
2. Collection and distribution of technical information on new products, processes, equipment, methods, and materials.
3. Distribution of information on pertinent technical papers, articles, and reports.
4. Continual information searches on subjects of special interest.
5. Maintenance of a catalog file, a technical data file, a file of company reports and engineering photographs, and a central microfilm file.

Services provided by the staff do not include detailed engineering work. Its sole function is to find and collect the necessary information requested and to present it to the requester. How the information is used is his responsibility.

*Formerly Manager of AMF's Technical Information Dept.

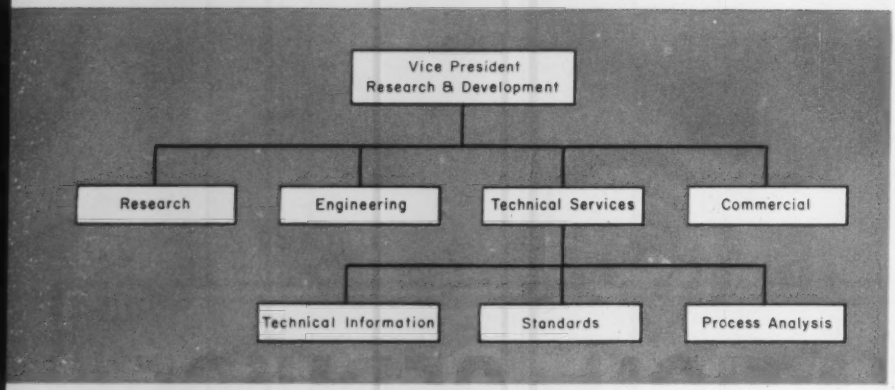


Fig. 1—Position of Technical Information Dept. in AMF organization. The Research and Development Div. is part of the corporate organization and is under the direct supervision of top management.

How Services are Provided

Depending on the nature of the request, technical information may be supplied in several different forms:

1. Formal report
2. Memo report
3. Lists of data
4. Bibliographies
5. Office memorandum

Requested papers and articles are procured and filed, with one copy going to the requester. If articles with information of known interest to personnel are found, copies are reproduced on a photocopy machine and sent to the persons interested.

Information sources are many and varied, but include libraries, conventions, and trade shows and associations. These sources are augmented by personal contacts and talks with salesmen and manufacturer's representatives. In addition, to keep abreast of technological advances, some 50 trade and technical periodicals are scanned regularly.

Scope and variety of services performed are illustrated by the following typical assignments to fill specific requests:

Procure all available literature and a list of subcontractors experienced in explosive forming of metals.

Procure data on the state of the art of charcoal making, explore the economics of charcoal in the northeastern section of the United States, find required production equipment, and procure marketing information.

Compile an international bibliography of literature on high-temperature strain gages and methods used to transmit strain signals from rotating machinery.

Files and Records

Because of the scope and diversity of AMF's interests and activities, several files are required for information storage.

A catalog file is maintained on mechanical, hydraulic, pneumatic, electrical, and electronic components. This file contains fly sheets and pamphlets as well as bound catalogs.

A technical data file consists of copies of pertinent technical articles from trade and engineering periodicals, reprints of papers, engineering data from venders, and any other engineering information of general interest. This file has proved its value many times in tracking down specific technical articles, as well as supplementary literature on the same and related subjects.

In addition, two other files are maintained. The Technical Information Dept. acts as a central storage point for reports generated by the Research and Development Div. One copy of each report is kept on file. Also on file are photographs of every piece of experimental or prototype equipment built by this division.

For disaster purposes, AMF has a microfilm program (35mm film in EAM Filmsort cards). A microfilm copy of each proprietary drawing prepared by the Research and Development Div., and certain other AMF engineering groups is on file in the Technical Information Dept.

Technical Information Cards

To keep personnel up-to-date on technical advances, information is circulated on "Technical Information Cards," Fig. 2. These 3×5 cards announce new products, processes, materials, and equipment that are available. They also are used to announce company reports and significant papers or articles. These cards are not the result of requests, but are prepared and distributed at the discretion of the Department. They are written to stimulate interest and response. If necessary, for either clarity or completeness, the reverse side of the card is also used, Fig. 2. If additional information on the card subject is requested, a copy of the pertinent manufacturer's literature, or of the report or paper announced is mailed to the requester.

The cards are prepared from information gathered from many sources. Most of the items are found in technical and trade periodicals. Other good sources are sales engineers and manufacturers' representatives.

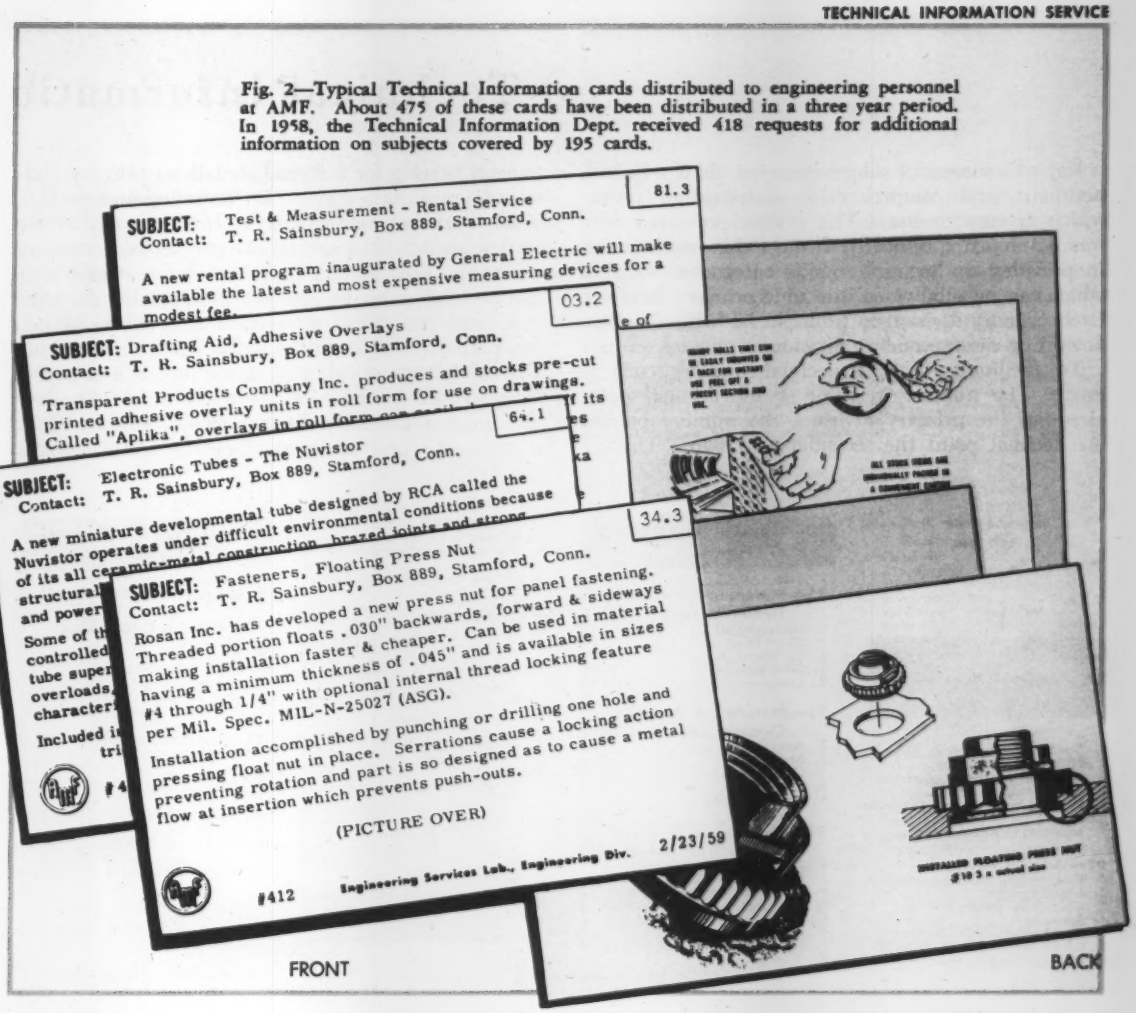


Fig. 2—Typical Technical Information cards distributed to engineering personnel at AMF. About 475 of these cards have been distributed in a three year period. In 1958, the Technical Information Dept. received 418 requests for additional information on subjects covered by 195 cards.

Indexing System

Since October 1956, about 475 Technical Information Cards have been prepared. Items covered include such diversified subjects as chlorofluorocarbon grease, heat-actuated pumps, modular-panel packaging, plasma torches, and boolean algebra. Although the cards were well received (418 requests for additional information on subjects covered by 195 cards issued in 1958), their usefulness has been hampered by lack of an effective indexing system for filing and quick reference.

Accordingly, a category indexing system has been developed for the cards (see *Technical Information Filing System*). This system was designed so that it could be used by engineers, draftsmen, or other technical personnel for their own files. It is ideally suited for a technical data file in an engineering department and is being used for indexing such a file in the AMF Technical Information Dept.

Company Organization

How the Technical Information Dept. fits into the over-all organization structure at AMF is shown in Fig. 1. The primary duty of the manager is to ensure that the department is doing an effective job of filling the technical information needs of the Research and Development Div., as well as other engineering groups within the organization.

Success of a technical information department is not insured by management sanction alone. Recognition of the department's role by engineers and other technical personnel is essential although difficult to attain. Solution is an alert, conscientious staff that understands and appreciates the problems of technical personnel and can fill their information needs quickly and efficiently.

Technical Information

Key to a successful subject-grouped file is a logical, pertinent, and comprehensive classification system which is easy to use. The system presented here was developed specifically to meet this requirement. It provides up to nine major categories, each of which can be subdivided into nine primary divisions. Each primary division in turn can be further broken down into nine secondary divisions.

To facilitate filing, a decimal number code is used. The number in front of the decimal point identifies the primary division, the number behind the decimal point the secondary division. Thus, a journal bearing for a driveshaft falls in primary division 41, secondary division 6. Its code number: 41.6.

As a further refinement, reports and papers are filed separately in a special category in each primary division. This section is identifed by a zero after the decimal point in the code number for the subject category. Thus all reports and papers in primary division 41 are filed under code number 41.0. For ease of numerical filing in the reports and papers category, the number of the appropriate secondary division is added after the zero where possible. Thus, a paper or report on journal bearings for driveshafts

00—General Engineering

1. Data classification & filing
2. Numbering systems
4. Organization of engineering
5. Value engineering
6. Human engineering, psychology
7. Management engineering

01—Administrative
1. Engineering announcements
2. Reproduction
3. Technical library
4. Services
5. Purchasing
6. Office equipment
8. Miscellaneous

02—Management
1. Personnel
2. Industrial & public relations
3. Financial
4. Training
5. Sales, service, advertising
6. Patents & legal
7. Research & development

03—Drafting & Design
1. Standards, manuals
2. Drafting-room practice, simplified drafting
3. Dimensioning
5. Symbols
6. Graphic arts
8. Equipment, instruments

04—Strength of Materials
1. Stress analysis
2. Residual stresses
3. Fatigue, failure
7. Soil mechanics

05—Sciences
1. Mathematics
2. Physics
3. Chemistry
4. Solar energy
5. Geosciences
6. Medical, biosciences
7. Metallurgy

07—AMF Miscellaneous Products
1. Chemical
2. Petroleum
3. Baking & dispensing
4. Tobacco
5. Stitching
6. Cycle, wheel & rubber
7. Bowling

10—General Materials & Processes

11—Materials & Processes: Treatment Type
1. Impregnants
2. Heat treat
3. Carburizing
4. Shot peening
7. Desiccants

12—Materials & Processes: Cleaners and Polishing
1. Abrasives
2. Strippers
3. Cleaners
4. Polishes
5. Electropolishing

13—Materials & Processes: Surface Application
1. Platings
2. Chemical or conversion
3. Refractory coating
4. Coatings
5. Paint
6. Plastic
7. Decorative
8. Treatment

14—Materials & Processes: Adhesive
1. Rubber base
2. Resins, epoxies
3. Tapes
4. Pastes

15—Materials & Processes: Lubrication
1. Liquids
2. Grease, pastes
3. Solid film
4. Mold release
5. Antiseize
6. Coolants
8. Lubrication systems

16—Materials & Processes: Compounds, Gases & Liquids
1. Solvents
2. Mastics, putty, waxes
3. Fuels: Liquid & solid
4. Gases
5. Sealers
6. Liquids: General
7. Hydraulic fluids

20—General Materials & Processes: Basic

7. Friction: General data
8. Corrosion, erosion

21—Materials & Processes: Metallic
1. Ferrous
2. Stainless steel
3. Copper & alloys
4. Aluminum, magnesium, & alloys
5. Metals & alloys other than 1, 2, 3 & 4
6. Magnetic
8. Coated metals
9. Specials

22—Materials & Processes: Nonmetallic
1. Inert
2. Ceramics, cermets
3. Organic
5. Elastomer, rubber
6. Wood, paper
7. Glass
9. Combinations, miscellaneous

23—Materials: Fusible
1. Solder
2. Spray
3. Eutectic
4. Welding
5. Brazing

24—Materials: Mold & Cast
1. Powders
2. Sintered
3. Porous
4. Forging
5. Casting
6. Molding

25—Materials & Processes: Wire & Cord Types
1. Wire, cable
2. Electrical cable & wire
6. Cord, twine, rope, thread
9. Specials

26—Materials & Processes: Formed
1. Extrusions: Solid & tubular
2. Tubular
3. Structural forms
4. Bar, rod
5. Hose, sleeving
6. Stamping, expanded
7. Fibers

27—Materials & Processes: Flat
1. Tape
2. Film, sheet, plate
3. Cloth, fabric
4. Screen, perforate
5. Composition, reinforced
6. Laminates, film
7. Embossed, textured
8. Rigidized

28—Materials & Processes: Plastics
1. Thermosetting resins
2. Thermoplastic resins
3. Cellulosics
4. Naturals
9. Specials

30—Hardware, Fasteners, & General Data

8. Specials

31—Fixtures & Hardware
1. Brackets, gussets
2. Posts, spacers, shims
3. Dials, knobs, handles
4. Hinges
5. Pipe fittings
6. Springs

32—Isolators, Washers, Insulators
1. Washers
2. Gaskets, seals
3. Packings
4. O-ring forms
5. Grommets
8. Insulators, bushings

33—Identification & Equipment For
1. Nameplates
2. Labels, tags
3. Marking
4. Decals

34—Fasteners, Retainers, General
1. Rivets, nails, tacks
2. Clamps, latches, locks, quick disconnects
3. Blind fasteners
4. Retainer pins, retainers
5. Inserts: Threaded
6. Machines for
7. Screws, nuts, bolts
9. Miscellaneous

35—Mounts
1. Shock-vibration
2. Spring mounts
3. Slides
4. Casters, wheels

40—Mechanical

1. Hydraulics: Theory & design
2. Pneumatics: Theory & design
3. Mechanical: Theory & design
4. Vibration, shock

41—Shafts, Couplings, Bearings
1. Shafting, splines
2. Flexible, fluid & solid couplings
3. Cranks, collars, flywheels
5. Linkages, joints
6. Bearings, bushings

43—Gear Types
1. Gears: General
2. Spline, worm
4. Sprockets
5. Pulleys, drums

Filing System

is identified by code number 41.06.

The subject breakdown given here is representative of present AMF requirements. Only "active" numbered categories are shown. Omissions in the number sequence indicate "inactive" categories available for expansion or refinement of subject coverage.

One more element, which is omitted here,* is necessary to make the indexing system complete: An alphabetical listing of subjects, complete with code numbers for cross referencing. This breakdown should permit quick location of specific subjects without guesswork.

When a file item is indexed, selection of the proper subject category is an important decision. Many items can be filed in at least two categories. For example, insulating varnish could be taken as both varnish material and electric insulation and could be filed under either category or, possibly, under both. Conversely, finding an item in the file may require looking in two, or even more categories.

*Complete details of the AMF indexing system, including both numerical and alphabetical subject listings, are given in *Technical Information Filing System* published by AMF. For a complimentary copy, write, on company letterhead, to Engineering Services Laboratory, American Machine & Foundry Co., P.O. Box 889, Stamford, Conn.

44—Transmission Devices
1. Gear trains
2. Differentials
3. Constant & variable speed
4. Clutches, brakes (mechanical)
5. Chains, belts, sheaves
6. Cams, rods
8. Specials
9. Systems, design

45—Power Source & Prime Movers (Nonelectrical)
1. Combustion engines
2. Steam engines, boilers
3. Steam turbines
4. Heat motor: External
6. Jet engines, gas turbines, rocket motors
8. Specials

46—Hydraulic, Pneumatic, General
1. Motors, pumps, accumulators
2. Cylinders, valves
3. Fittings, controls
5. Blowers, fans
6. Tools
7. Compressors
8. Miscellaneous
9. Systems

48—Components
1. Counters

50—Electrical

1. Power circuitry
2. Lighting circuitry
4. Insulation: General
5. Electrochemical devices, electrofluids
6. Electromechanical devices
7. Theory, design

51—Power Sources
1. Batteries, cells
2. Generators, motor generators
4. Transformers
6. Switchgear
9. Specials

52—Motors
1. Subfractional
2. Fractional
3. Synchronous
4. General
5. Servo
6. Gearmotors
9. Specials

53—Control Equipment
1. Manual
2. Magnetic
3. Switches
4. Regulators, timers, cycle control
5. Solid state
6. Programmers
7. Servomechanisms

54—Conductors & Wiring
1. Standard
2. Special
4. Brushes, slip rings, contacts
5. Windings: General
6. Devices & machines for

55—Light Sources
1. Incandescent
2. Photoelectric
3. Fluorescent
4. Glow
5. Arc, mercury
6. Electroluminescence

57—Components
1. Starters: Motor
2. Switchboards
3. Synchros
4. Relays
5. Solenoids, thrustors
6. Networks
7. Horns, buzzers, pilot lights
8. Clutches, brakes (electrical)
9. Fuses

58—Components
1. Breakers
2. Commutators
5. Transducers

60—Electronics

1. Circuitry
2. Printed circuitry
3. Computers, programming
4. Instrumentation
7. Theory, design

61—Capacitives
1. Capacitors
2. Electrolytics
3. Dielectrics
4. Air, gas, vacuum
5. Materials, composition
9. Specials

62—Resistives
1. Resistors: Fixed & variable
2. Materials, composition
3. Wire wound, film
4. Heater elements
7. Nonlinear
9. Specials

63—Semiconductors
1. Rectifiers
2. Diodes
3. Transistors
4. Photo sensitive
9. Specials

64—Tubes
1. Vacuum
2. Gas
3. High frequency
4. Indicator type
5. Counters
6. X-ray
7. Traveling wave

65—Connectives & Contactors
1. Contacts, rings, brushes
2. Hermetic seal type
3. Terminals, binding posts
4. Jacks, plugs, receptacles
5. Printed wiring boards, cable assemblies
6. Waveguide devices
7. Antennae

66—Systems & Equipment
1. Communications
2. Television
3. Radio
4. Radar
5. Feedback Control
6. Data recording
7. Telemetering
8. Power supplies
9. Specials

67—Components
1. Sensing devices
2. Convertors, vibrators
3. Chokes, choppers, filters, coils
4. Speakers, baffles
5. Amplifiers
6. Reactors
7. Frequency devices
8. Fittings
9. Transmitters, oscillators

68—Components
1. Counters

70—Optical, Nuclear, Acoustics & Miscellaneous Devices

71—Optical
1. Photography: General
2. Lenses, scopes
3. Microfilm
4. Infrared, ultraviolet
5. Instruments
7. Theory, design

72—Nuclear
1. Reactors, particle accelerators
2. Radiation, fuels
3. Shielding, detection
4. Heat transfer
5. Instruments
6. Hazards
7. Theory, design

73—Acoustics
1. Transducers
2. Ultrasonics
3. Audio
4. Instruments
5. Detectors
7. Theory, design
9. General

80—Engineering: Miscellaneous

2. Automation

81—Test, Measurement, and Equipment for
1. General
2. Mechanical
3. Electrical, electronics
4. Environmental
5. Hydraulic, pneumatic
6. Inspection methods, quality control
7. Nondestructive testing

82—Manufacturing & Processing Techniques & Equipment
1. General
2. Casting, forging, molding
3. Machining, cutting, grinding
4. Pressing, forming, punching
5. Welding, brazing, soldering, joining
6. Bonding
7. Drilling, boring, broaching
8. Tooling & accessories for

83—Process Equipment: Surface Application
1. Plating
2. Painting, spraying
3. Coating
4. Cleaning, polishing

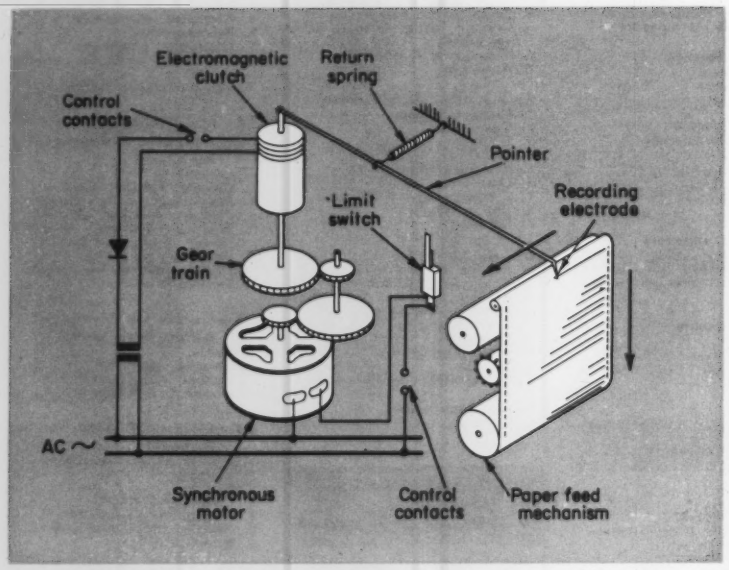
84—Closures, Packing, Packaging
1. Specifications, regulations
2. Methods
3. Vessels
4. Containers: Rigid
5. Containers: Collapsible
6. Bracing, cushioning
7. Equipment for

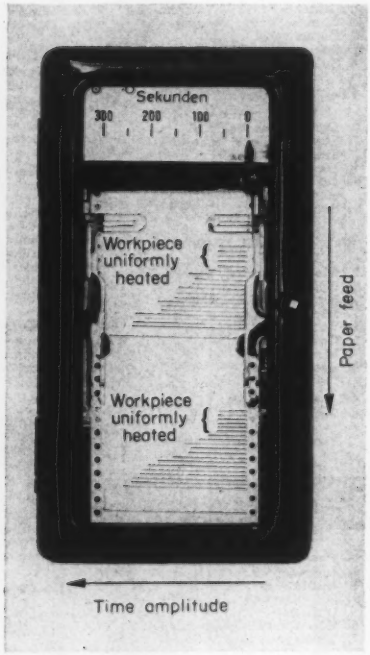
85—Processes & Manufacturing Equipment
1. Chemical
2. Metal (basic)
3. Petroleum
4. Food
5. Tobacco
7. Rubber (manufacturing equipment only)

87—Plant Operation
1. Construction, maintenance, utilities
2. Production
3. Administration
4. Material handling
5. Cost control
6. Assembly methods
7. Safety
8. Transportation

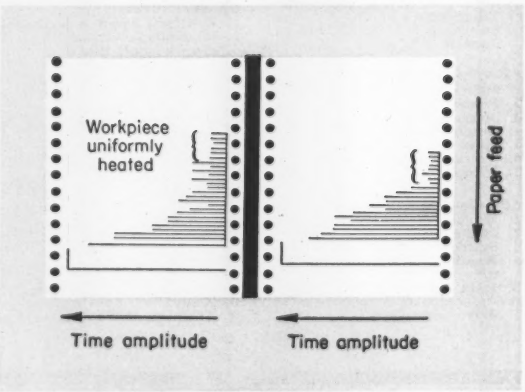
88—Heating & Heat Transfer
1. Heaters, furnaces, including hi-frequency
2. Exchangers, economizers
3. Refrigeration, low-temperature equipment
4. Heat pumps
5. Insulation: Thermal
6. Heat storage
8. Accessories for

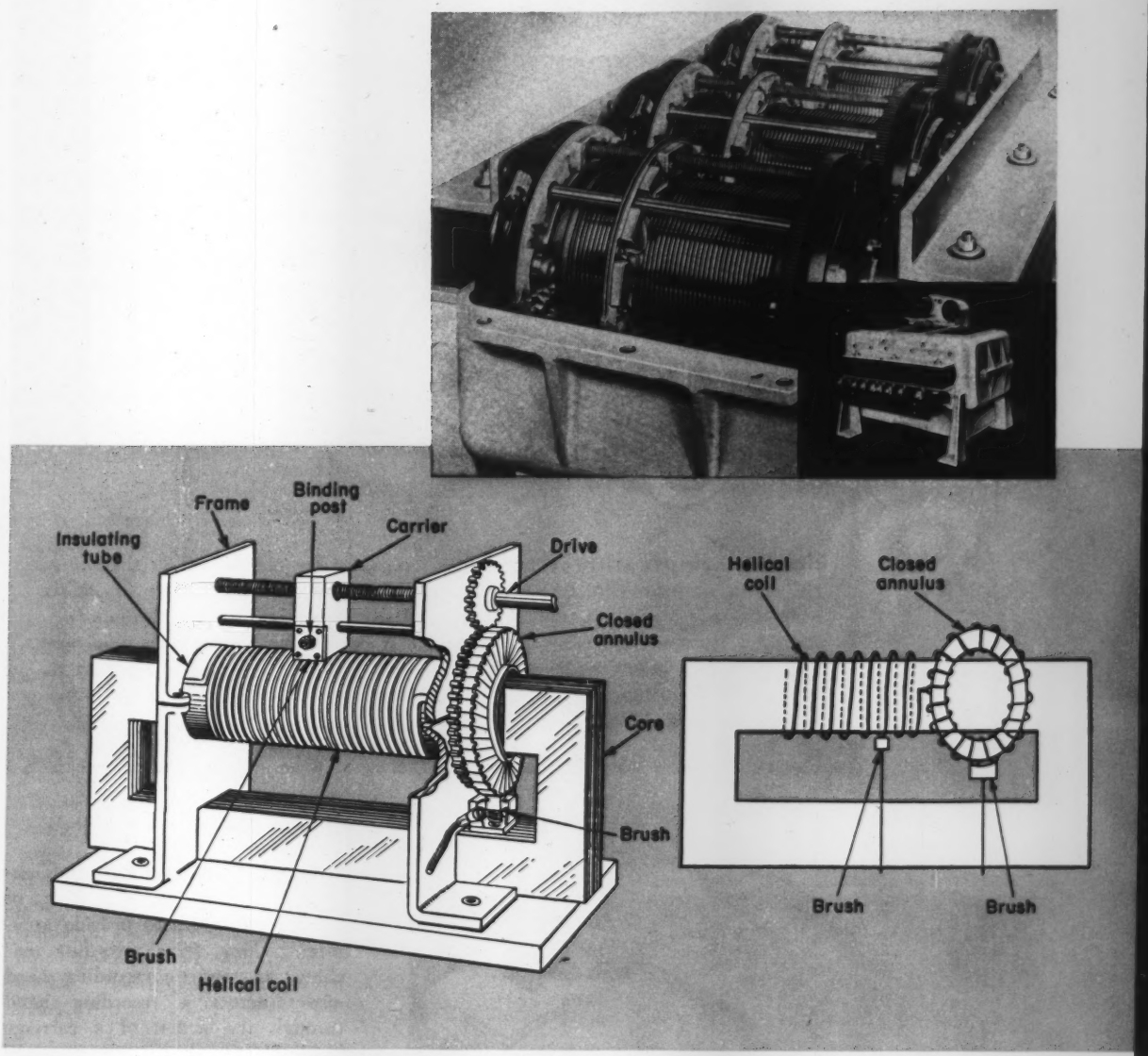
scanning the field for *ideas*



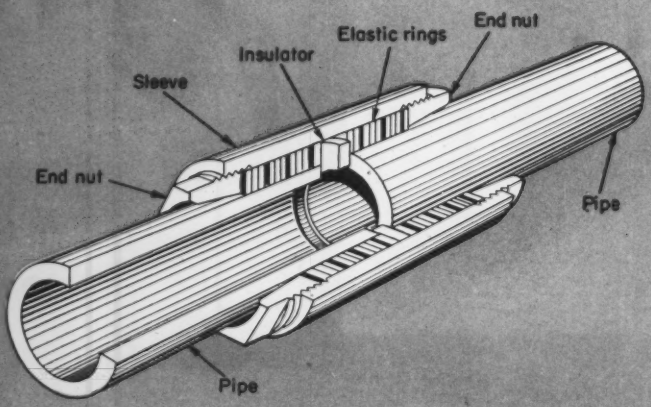


Parallel time-amplitude lines on a recorder chart indicate when a thermal balance (uniform temperature) is obtained in a thermocouple-controlled heating process. As the part being heated approaches the desired temperature, the time-amplitude lines, which represent periods of heat supply or furnace operation, decrease in length. As soon as thermal balance exists between the interior and exterior of the workpiece, the furnace operation time becomes uniform each time the furnace goes on. Hence, the time-amplitude lines become equal in length. Design eliminates guesswork required if uniform heating is to be accomplished with only surface-mounted thermocouples. Recording principle employed in furnace control system developed by Allgemeine Elektricitaets-Gesellschaft (AEG), Heiligenhaus/Duesseldorf, Germany.

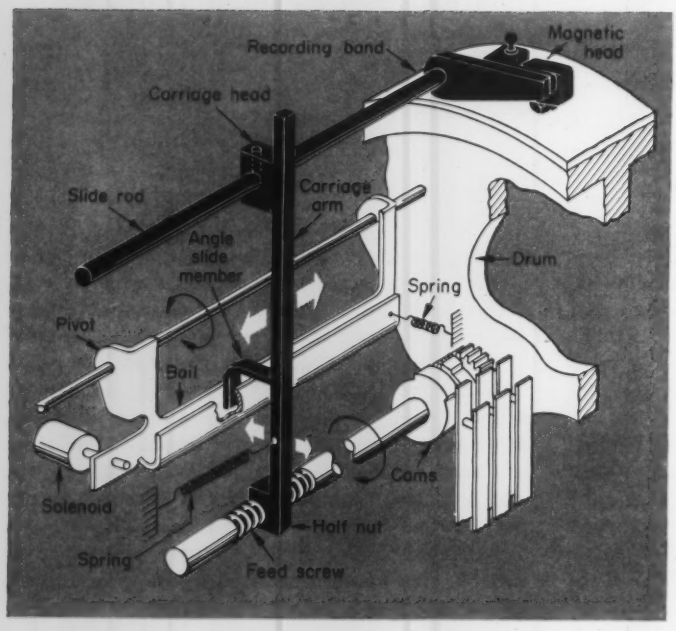




Helical-wound coil construction reduces heat generation and loss of power in adjustable-voltage transformer. A helical winding, with adjacent turns which have a uniform and close spacing, is secured on an insulating tube. A closed ferromagnetic core, with a leg extending longitudinally through the tube provides a closed magnetic circuit of low reluctance through the length of the winding. Frame members are insulated to prevent the formation of a closed electrical circuit about the core. A brush, movably mounted and insulated from a carrier, is forced into slidable engagement with a short length of one turn of the winding. A drive mechanism rotates and advances the brush simultaneously. In continuous contact with the winding, the brush can be positioned to engage any portion of any single turn. A closed annulus, forming a winding about the magnetic core, is connected at one point to the terminal board. A second brush makes electrical connection with a selected portion of the annulus, and is connected electrically to the sliding brush on the helix. Alternating current is fed into the helical winding and output voltage is taken off through the brushes. This voltage is controlled by the selected engagement of the brushes with the helical coil and with the annulus. Coil construction employed in patented variable transformer developed by Superior Electric Co., Bristol, Conn.

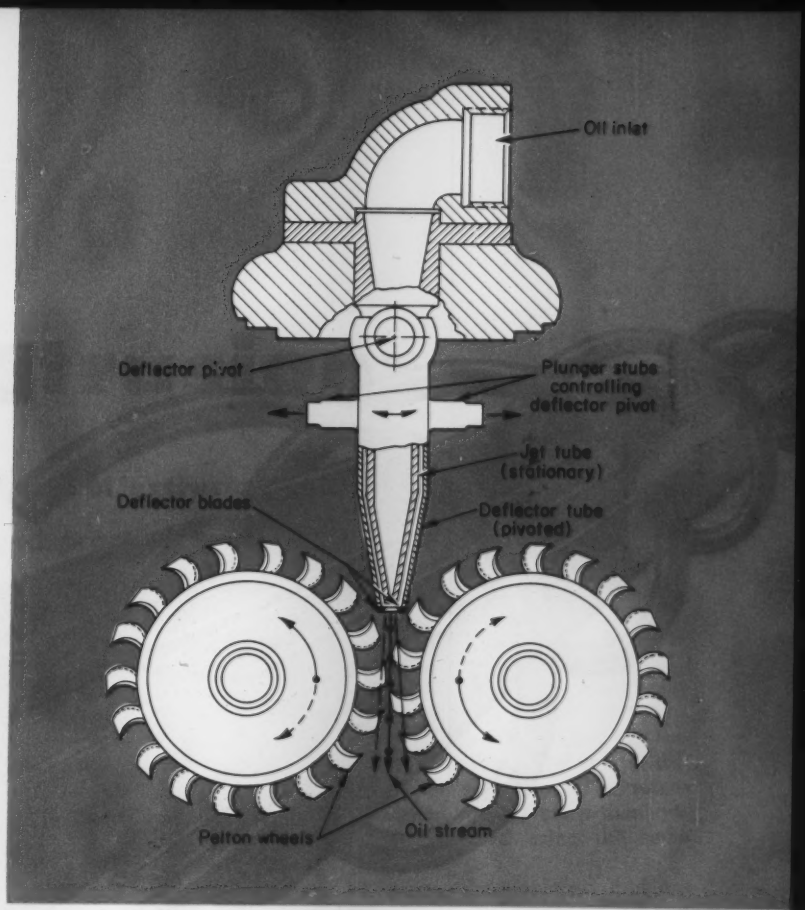


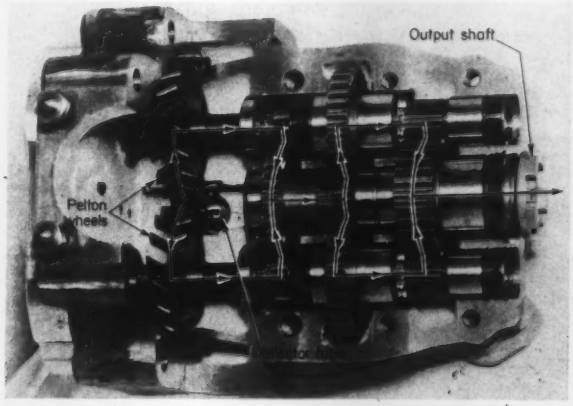
Elastic compression rings permit pipes to be joined without threading. The elastic rings are contained in a sleeve by two end nuts. As the nuts are tightened, the rings are forced to expand radially, forming a tight, flexible friction joint between pipe OD and sleeve ID. A center ring insulates the pipe sections from each other to prevent the transmission of sound. Reported by Alan K. Jackson, elastic rings employed in a pipe coupling developed by Metallwerke Neheim, Goeke and Co., Neheim-Hustin, Germany.

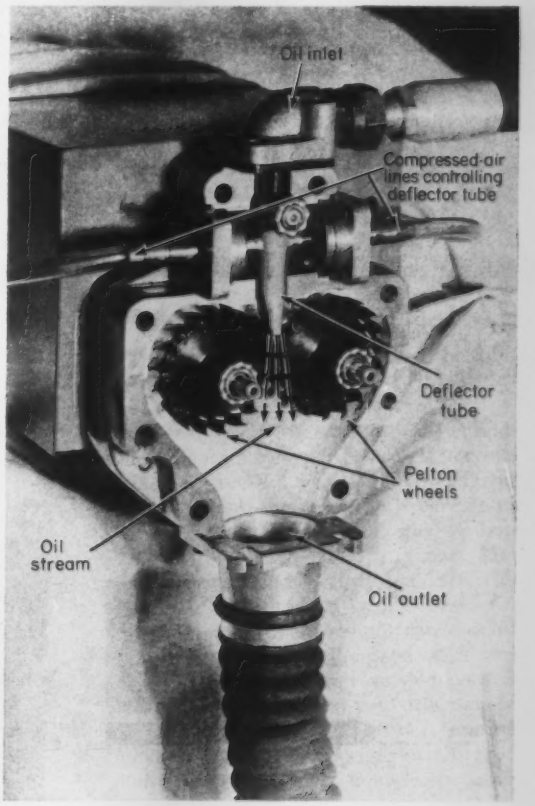


Swinging half-nut controls engagement and disengagement of power-screw drive to provide accurate tracking. In a recording machine, a magnetic recording head moves across a recording band through the action of a carriage head. To set the carriage arm in motion, a solenoid is actuated which swings a spring-loaded bail around a pivot. The lower portion of the carriage arm is engaged in the bail by an angle slide member. As the bail swings, the lower portion of the carriage arm moves the half-nut into engagement with a feed screw and the entire arm, carriage, slide rod, and recording head move. De-energizing the solenoid disengages the nut. Reported in *Bell Laboratories Record*, engagement principle employed in an announcement machine developed by Bell Telephone Laboratories Inc., New York, N. Y.

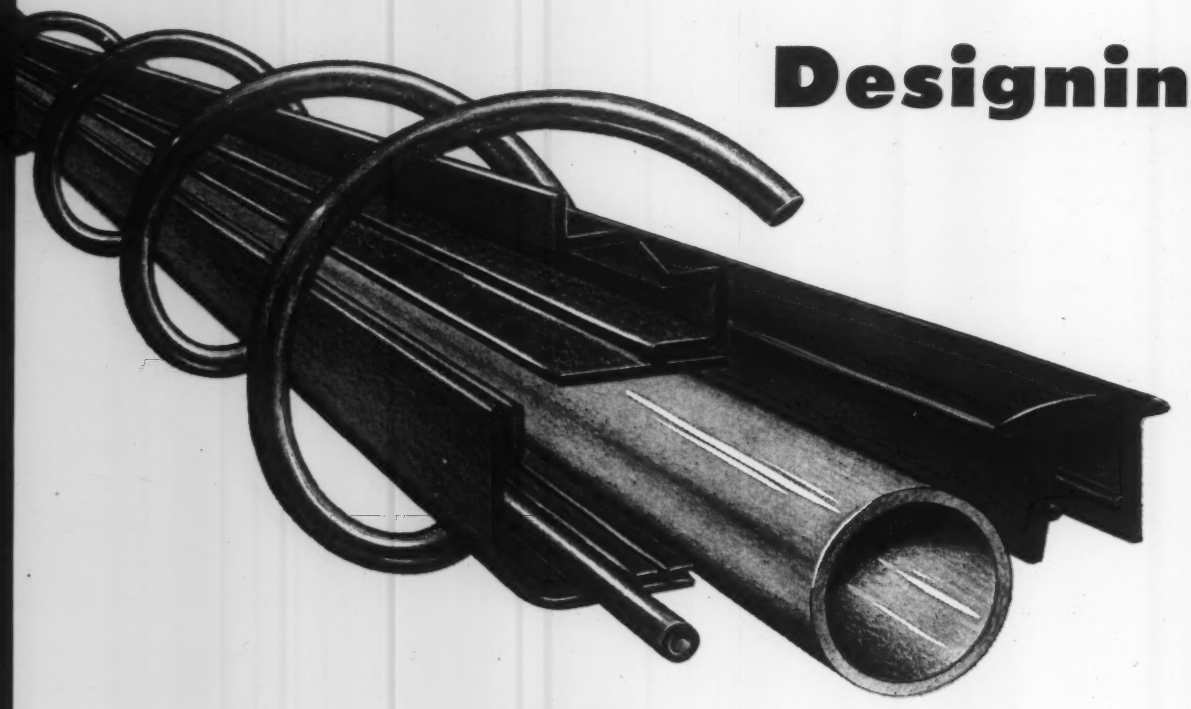
Proportionally deflected oil stream drives two Pelton-type wheels to produce infinite speed variations with minimum response times. Deflection is accomplished through pivoted deflector tube which is wrapped around a stationary jet tube and cuts into the ejected oil stream with sharp blade edges. The oil passes through the jet tube, which has rapidly diminishing cross section to increase the oil velocity, and impinges on the Pelton wheels which are geared to the output shaft. While one of the wheels is driven by the oil stream, the other one opposes it. If the oil stream is directed at center between wheels, the drive is at a standstill. The more the oil stream is deflected to either side, the higher the output speed. Direction of output shaft rotation is determined by the wheel receiving the larger portion of flow. The deflector tube is pneumatically or electrically positioned. Hydraulic drive principle employed in oil-pressure feed turbine developed by Chiron-Werke GmbH, Tuttlingen/Wuertt, Germany.



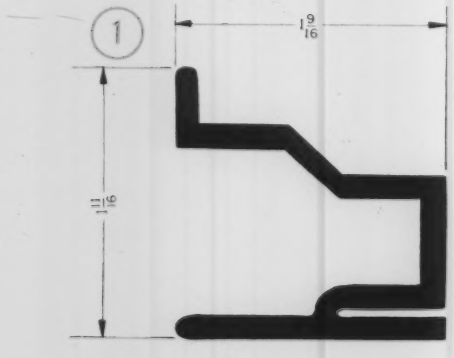


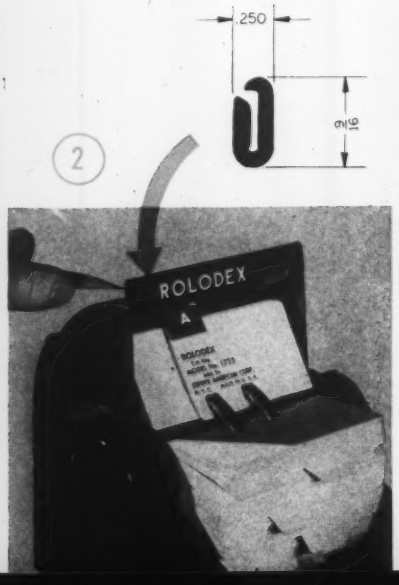


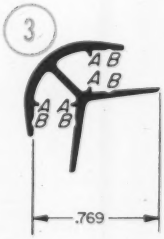
Designing



ROBERT MARX
Development Engineer
Anchor Plastics Co. Inc.
Long Island City, N. Y.







Plastic Extrusions

A practical sample book of extrusion cross sections showing good and bad practice in design—

FOR plastic parts with uniform cross sections, extrusions are usually more economical than similar parts made by injection molding, machining, or vacuum forming. Extrusions are especially suitable for long parts, solid or hollow. But for extremely short pieces with uniform cross sections and thin walls, an extrusion—precision cut to length on automatic machinery—is usually easier to make than an equivalent molded part.

Once a cross section has been determined, different-length parts can be obtained from the same die. Injection molding is, of course, limited to one particular length. Thus, in a product requiring a multitude of sizes of a certain part, the slightly greater cost of the individual extruded pieces is offset by a margin of several hundred per cent when the costs of the various injection-molding dies required for each length are amortized in the piece prices.

Tooling costs are low. Extrusion dies usually range from $45 to $300. Die changes are nominal-cost or free, and design changes such as flutes, beads, flanges, or sections can usually be incorporated easily into a finished extrusion die.

Materials can usually be selected to meet particular conditions, and even in one material several different formulations may be available. The extrusion die is usually designed so that more than one plastic material can be extruded using the same tooling.

Extrusions are, of course, thermoplastic, and are not recommended for structural components bearing heavy loads, or for long, unsupported sections bearing any load. Although some of the new thermoplastics are suitable for temperatures above the boiling point of water, really high temperatures are outside the scope of extruded thermoplastics. Compression and tensile strengths do not approach those of most metals.

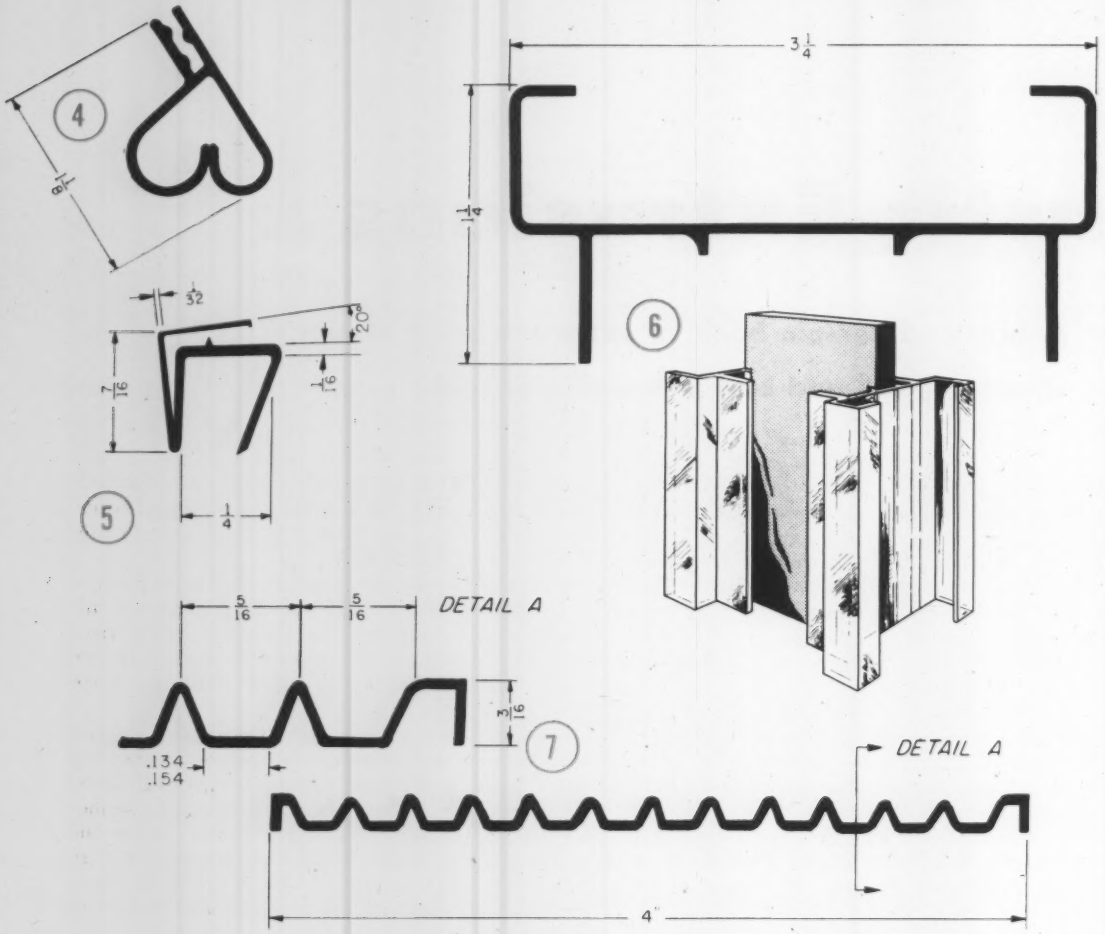
Uniform Walls

MAINTAINING uniform wall thickness through the cross section is probably the most important design consideration, regardless of the intricacy of the shape. Uniform wall thickness promotes extrudability, prevents warping and unevenness of surfaces, and permits better surface finish. It is usually possible to obtain better tolerances on a shape with uniform wall thicknesses than on one which is extremely heavy or has adjacent sections of greatly differing thicknesses.

Intricate profiles can be extruded if cross-section thicknesses are uniform. For instance, the railroad-car shade guide in Fig. 1 is a relatively large extrusion with a heavy wall held to close tolerances. Material is ethyl cellulose.

Used as a combination nameplate-handle on a rotary index file, a narrow, hooked channel, Fig. 2, is snapped over a lip of the file cover so it cannot be removed. The 9/16-in. flat is hot-stamped with the product name. Material is cellulose acetate butyrate; color, black.

A comparatively simple corner-joint molding, Fig. 3, is designed with several features. Curved outside portion is toed in slightly to grip the panels. Four inside lugs, *A*, position mating panels. Concave depressions, *B*, hold an adhesive which completely seals



the assembly and holds the extrusion in place. Material is cellulose acetate butyrate; color, brown.

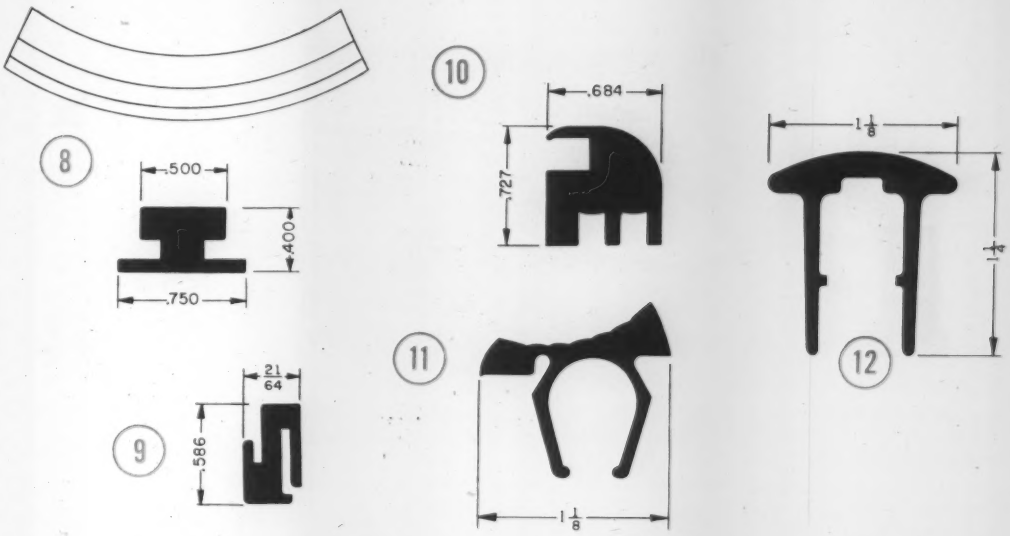
4 Upper channel of a clear, complex price-tag holder shape, Fig. 4, grips a printed card. Bottom can snap over various thicknesses of plate glass or other partition materials. To obtain maximum clamping force, the two curved legs have to be extruded so that they touch, preferably under some compression. But if the two legs were permitted to touch while exuding out of the die, they would stick to each other. Special postforming jigs overcome the problem. Another price-tag

5 holder, Fig. 5, has enough uniformity to be considered of even wall thickness.

6 A very large, clear multichannel extrusion, Fig. 6, makes a display-dispenser device. Two channels are mounted on a flat wood block fitting between short projections. With two extrusions, four channels are obtained for merchandise. Clear butyrate permits observation from all angles.

7 A uniform-wall extrusion for packaging glass plates, Fig. 7, is quite complex. Twelve channels must be held to close tolerances, and over-all width has to be controlled. Furthermore, none of the channel side angles are allowed to come too close to 90 degrees. Material is high-impact styrene, a rigid material similar to general-purpose styrene but with greater impact resistance. This shape is cut to very short lengths. Even slight burrs could not be tolerated. So a male and female cutting die is used, requiring extremely close tolerances over the complete cross section.

Differing Wall Thicknesses



SOME extrusions with differing wall thicknesses are very difficult to extrude. Others, although they look just as complex, are not a problem. In all cases, considerable extrusion skill is necessary to achieve proper tolerances on openings, avoid sink or shrink marks, prevent bows in long sections and produce even, smooth surfaces without ripples.

8 A combination breaker strip and door frame, Fig. 8, is used in the refrigerator compartment of a water cooler. The inside of the heavy rectangle cools slower than its outside skin. Thus, a slightly concave upper surface is sometimes unavoidable, since the cool, solidified outer skin is pulled in by the still-shrinking inside portion as it cools. Additionally, the heavy section cools much slower than the thin bottom flange. So slight warping tendencies also have to be controlled. Material is ethyl cellulose, used because of its toughness and superior low-temperature qualities.

9 Even though heavier sections are combined with thin sections in the breaker strip in Fig. 9, the over-all shape is more uniform than that in Fig. 8. And, since the shape in Fig. 9 is extruded of high-impact styrene, a material which is easier to extrude than the ethyl cellulose used for the shape in Fig. 8, excellent results are achieved. Color is blue.

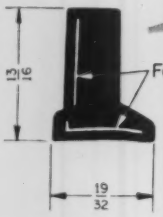
10 The panel-joint and track combination for an all-glass showcase, Fig. 10, represents an exceptionally difficult and intricate extrusion even though, at first glance, it may not appear that way. The part is made of clear butyrate, appearance being of prime importance. There are several problems: 1. A heavy, slow-cooling mass of material on one side with shallow, close-tolerance channels on the other. 2 All channels have to be aligned very accurately with respect to each other. 3. A heavy mass of material is required for strength, and for sufficient body to receive screws.

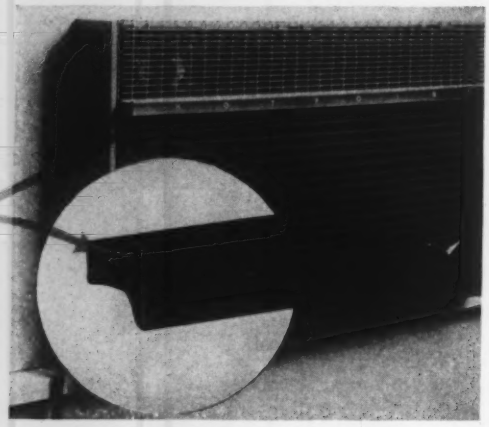
11 The air-conditioner filter holder in Fig. 11 is one of the less-desirable sections from an extrusion standpoint. Thin legs join a heavy, nonuniform top which, in itself, is divided into two blocks of material joined by a thin bridge. Warpage and nonuniform extrusion result. An additional complication is the necessity to hold the convoluted top surface accurate to fit an injection-molded nameplate. Considerable experimenting was required before the shape could be delivered in acceptable condition.

12 A more easily extruded filter holder is shown in Fig. 12. Cross section is uniform, and undercuts are not needed. Precise control of the convex upper surface is required because this portion is hot stamped. Cellulose acetate butyrate in matching colors was specified for the shapes in Fig. 11 and 12 because of high-gloss finish obtainable in this plastic

Foil Inserts

13





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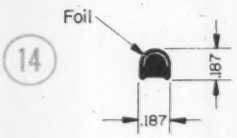

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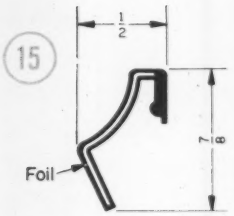


A PROCESS developed by Anchor Plastics uses thin aluminum foil bonded integrally into the plastic extrusion to give the final effect of polished brass, copper, chrome, etc. Cellulose acetate butyrate is most used for such metal-like moldings. Permanency of finish is assured by embedding the aluminum foil appromately 0.020 in. under the surface of the tinted plastic.

13 One of the most complex extrusions of this type is shown in Fig. 13. Two bright aluminum foils are extruded into the heavy cross section. The 19/32-in. surface is later hot-stamped, while holes are drilled in the opposite surface for mounting the molding.

14 A similar shape is shown in Fig. 14. One curved foil is precisely extruded into the half-round top of this trim molding. In this case, bonding-in of the foil is particularly important, since the small trim molding is bent in both horizontal and vertical planes, and wrinkling of the enclosed foil cannot be tolerated.

Extrusions containing foil are best designed with sharp foil bends kept to a minimum, total width of sections not over 3 in., and plain, flat sections broken up with ribs, flutes or patterned foil.

15 The shape in Fig. 15, because of the foil insert, is an intricate extrusion, since the 0.003-in. aluminum foil must be aligned accurately inside the extruded plastic molding. Any variation in thickness of plastic over the highly polished foil would result in an uneven appearance. A uniformly curved section rather than the sharp corners would be more desirable.

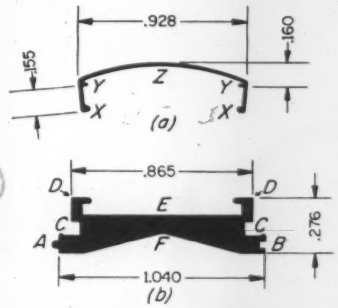
Extrusions Replacing Other Parts

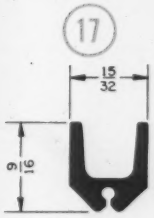
SOMETIMES a metal part, a wood molding, or a machined part is originally designed, and drawings later submitted to plastic extrusion firms for quotation. Usually, the shape must be revised to make extrusion easier, improve the component, or make it more economical.

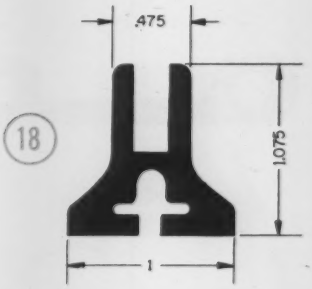
19 The shape in Fig. 19*a* represents such an extrusion; the wood molding previously used is shown in Fig. 19*b*. A reduced wall thickness was recommended, and the center leg of the channel was undercut to make the wall uniform while keeping the same effective width. The channel is a base molding for the wooden sound box of a musical instrument.

20 A corner molding, Fig. 20*a*, was originally designed as shown in Fig. 20*b*. This corner molding conceals the butt joint of two bullet-proof glass panels in a drive-in bank-teller cage. A stiff yet nonmarring material is desirable. The shape in Fig. 20*a* was ultimately adopted. The hollowed-out side gives better extrudability, and better seating of the molding edges against the glass panels. Since the part is held in place by screws, a solid center leg is not necessary. Use of two adjacent legs instead of one bulky block, makes the section uniform without reducing strength.

Complex Cross Sections







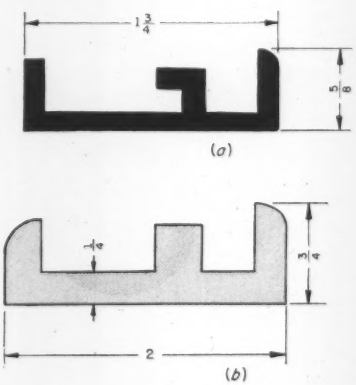
THE problem of producing very complex cross sections can often be compounded if the extrusion must fit other parts, or if close tolerances are needed.

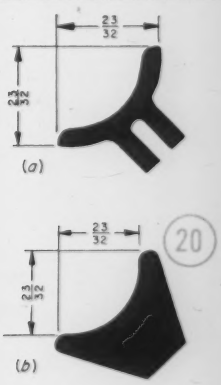
16 For instance, Fig. 16*a* is a clear butyrate extrusion which slides over a precision-extruded acrylic part, Fig. 16*b*, a component of a scheduling board.

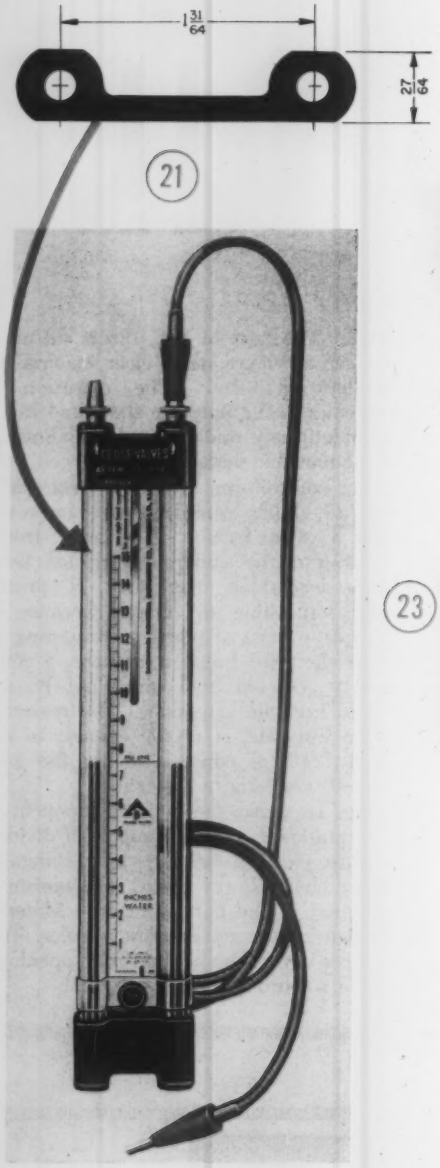
The shape in Fig. 16*b* must meet several conditions. The extrusions have to be straight since they are assembled adjacent to each other on a board by means of tongue *A* and groove *B*. Channels *C* accommodate the sliding part in Fig. 16*a*, and its projections snap into these recessed channels. At the same time, projections *Y* of Fig. 16*a* slide on point *D* of 16*b* which, of course, necessitates close tolerances between channel *C* and point *D*. In the part in Fig. 16*a*, a paper designation strip is inserted in channel *Z*. A sliding cardboard signal is inserted in channel *E* of Fig. 16*b*. Recess *F* on Fig. 16*b* performs the dual function of permitting the part to seat flat against the board, as well as eliminating excess material. The part in Fig. 16*b* is extruded of clear acrylic, a hard, clear material of excellent stability. The extrusion is harder than the butyrate slide, and holds up indefinitely under the slight abrasion of the movable signals.

17 A nonuniform channel extrusion, Fig. 17, holds sample glass plates inside a wire frame. The wire frame snaps into the undercut extruded hole. Once assembled, the wire is practically impossible to remove because of the heavy mass of plastic surrounding it. Since the wire frame is prebent, a completely enclosed hole could not be designed into the extrusion. The material, white butyrate, is elastic enough to expand 1/16 in. when receiving the wire without cracking or distorting.

18 Fig. 18 shows the major component of a spring-loaded, counter-top shelf divider. A glass panel is held in the rectangular upper channel; the spring mechanism is mounted in the bottom recess. Material is high-impact styrene, silver color. Tolerances have to be held on both openings, and a smooth surface is essential.



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1.250 DIA
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24
.750
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.625
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29
.828 DIA
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.100
.687
.093
.500

SINCE holes in almost all hollow extrusions are kept open by air pressure for the first few seconds after the hot plastic leaves the die, they tend to assume a round shape if the containing wall is even. Air pressure, however, expands thinner sections more than thicker sections. So it is almost impossible to obtain completely round holes in uneven cross sections in thermoplastics. One exception, though, is rigid vinyl.

21 A multiple-hole extrusion, Fig. 21, shows that even heavier sections, as long as they are uniform, can be extruded with enough accuracy (±0.010-in.) to serve, in this case, as a manometer. The slight irregularity in wall thickness around the tubes (the flat areas assist in reading liquid levels) do not affect the inside diameters of the tubes since the difference in thickness is very slight. In this case, dimensional tolerance on each hole ID is approximately double that of a single plain tube of a similar diameter. Material is clear butyrate.

22 Tubular sections in Fig. 22 and 23
23 represent good examples of well-designed irregular tubular sections of uniform wall thickness. Used on office-partitions, the part in Fig. 23 slides over formed metal legs. Sharp corners are required, and the die was designed to achieve this. But die costs would be less if sharp corners were not specified. Material is cellulose acetate
24 butyrate.

25 Fig. 24 and 25 show cored-out sections in which a round hole is not obtained. In both cases, even though the holes shown are round, the final result is really a hexagonal hole. However, hole configuration does not matter in these parts; the handle section in Fig. 24 goes over a steel structural rod, and a screw is inserted in the spacer extrusion in Fig. 25. Black butyrate is used for the part in Fig. 24; clear styrene for Fig. 25.

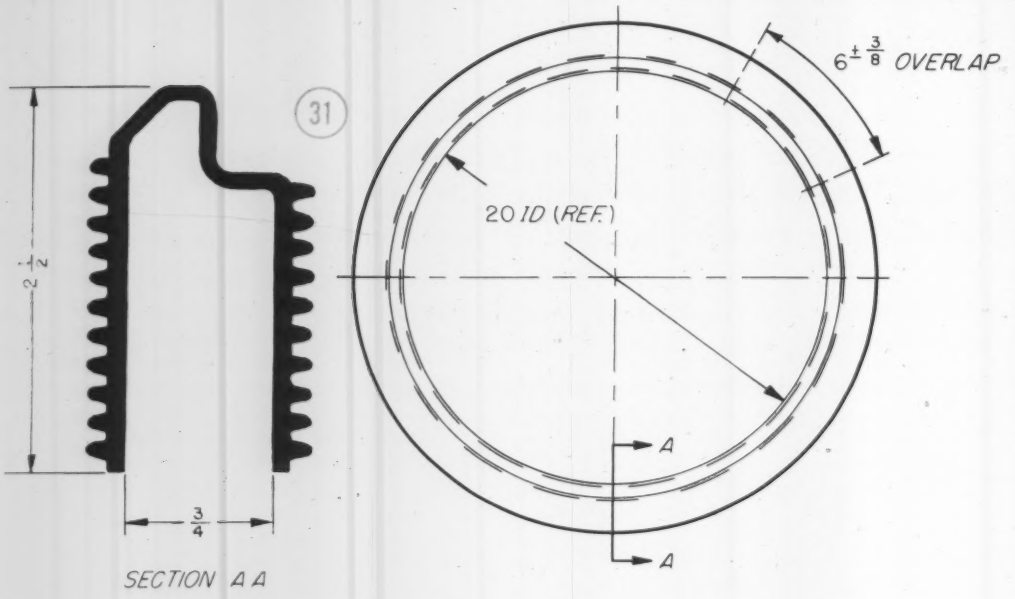
26 The specified round hole in Fig. 26, a red linear polyethylene handle section, tends to become oval because of differences in shrinking rates between the heavy and thin wall sections.

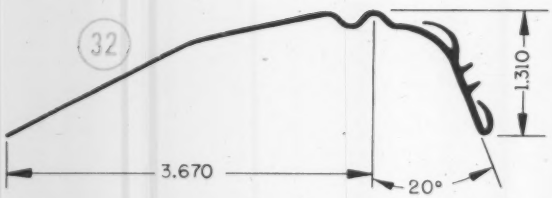
27 The hole in Fig. 27, an index tab extrusion of clear butyrate, receives the paper designation strip. The ideal hole shape shown is not achieved; the parallel sides bow out slightly—of no consequence in this application. The bow could be completely eliminated if the walls were slightly thicker and the flange eliminated. Such is the case
28 in the tube in Fig. 28, a high-impact styrene extrusion. The flat sides are parallel when extruded.

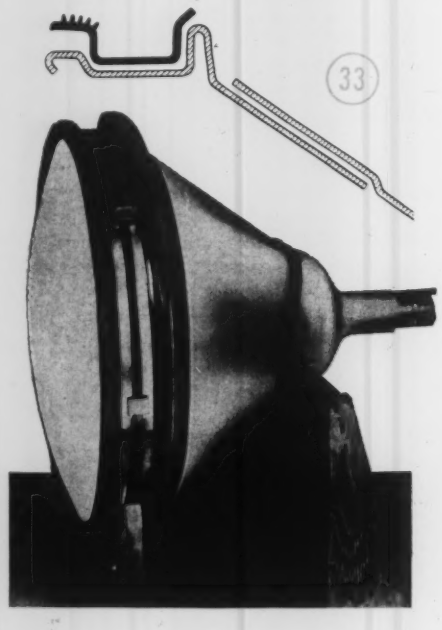
The tubular section design in Fig.
29 29 is not recommended for thermoplastic extrusions. The heavy wall by itself would not cause any difficulty. But, the slot designed into the ID makes this shape so unbalanced that the hole will not center, and the diameters will be out of round. A better solution
30 for a keyed tube is shown in Fig. 30. Four evenly spaced inside projections (more can be used) allow keying without interfering with extrudability.

Diameter tolerances on tubular sections are generally within ±1 per cent except for very complex tubes, those with extremely heavy walls, and large-diameter tubes with very thin walls. On small - diameter round tubes, lower limits of ±0.002 and ±0.003-in. for tubes of 0.040 and 0.120-in. OD, respectively, are desirable.

Curved Extrusions





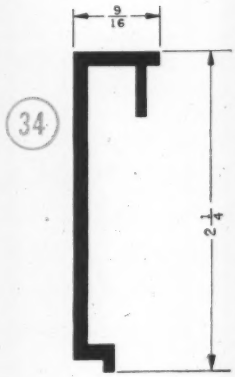


PLASTIC extrusions have to be heated to their softening point before they can be formed. It is impossible to obtain post-formed curved, deep channels or complex extrusions because, when thus heated, the extrusions collapse, distort, or melt.

A patented curved-extrusion process overcomes these problems, and actually supplies extrusions with undistorted cross-sections, preformed into curves and circles with diameters of 4 in. and up. Various thermoplastic materials may be specified.

31
32
33

The shapes in Fig. 31, 32, and 33 are examples of curved extruded sections of considerable complexity which can be made by this process. Although the sections in Fig. 31 and 32 are both polyethylene, the process can be employed for most extrudable thermoplastics. Tooling costs for curved extrusions are only slightly more than those for plain extrusions ($200 to $400 range). They are still, however, only about 5 to 10 per cent of the mold cost for an equivalent injection-molded part.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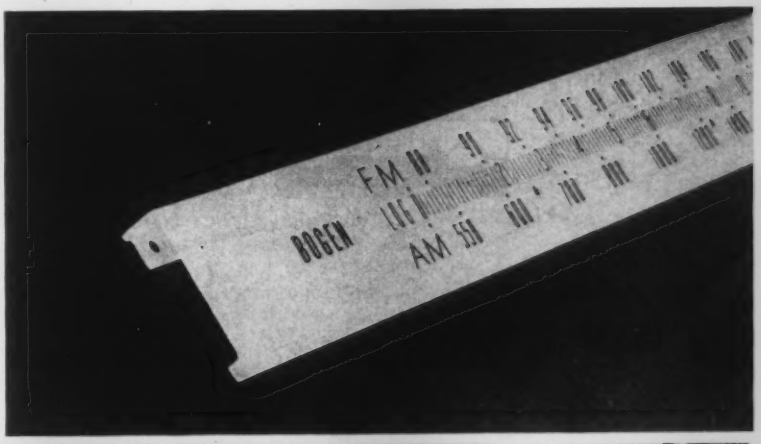
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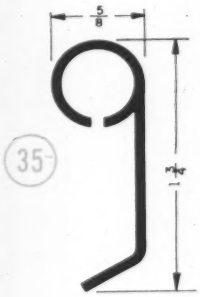
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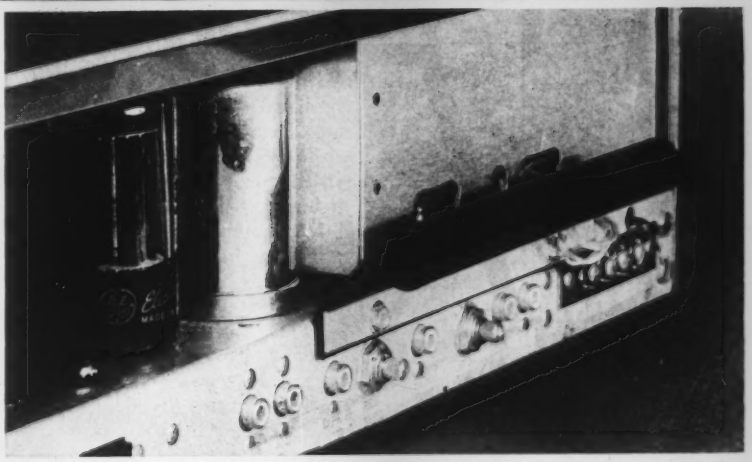

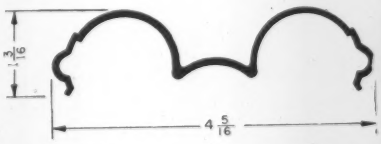
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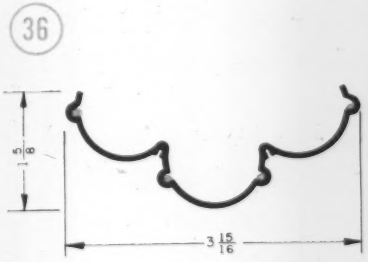
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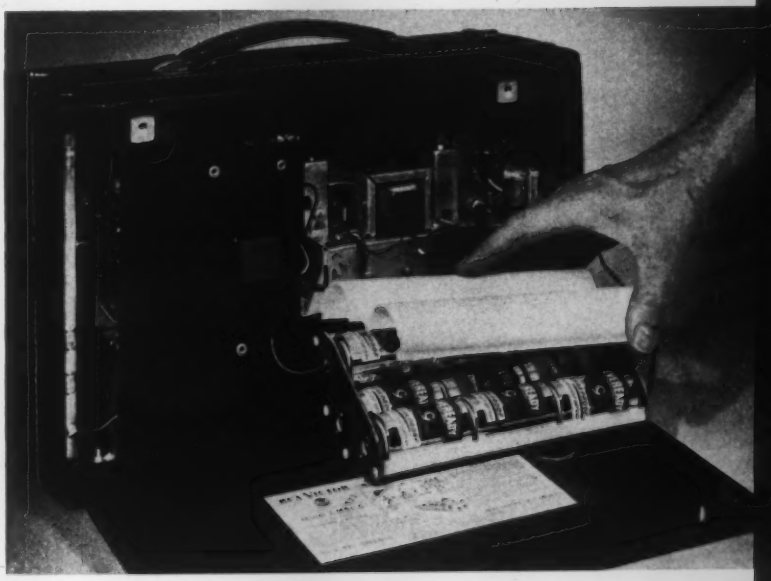

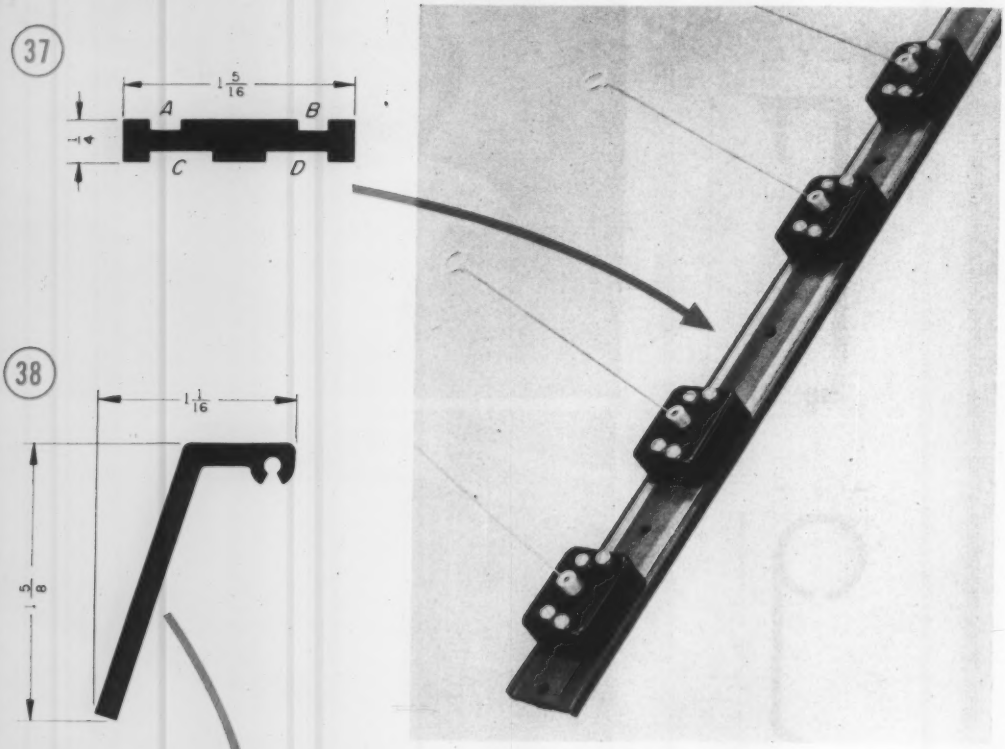
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A
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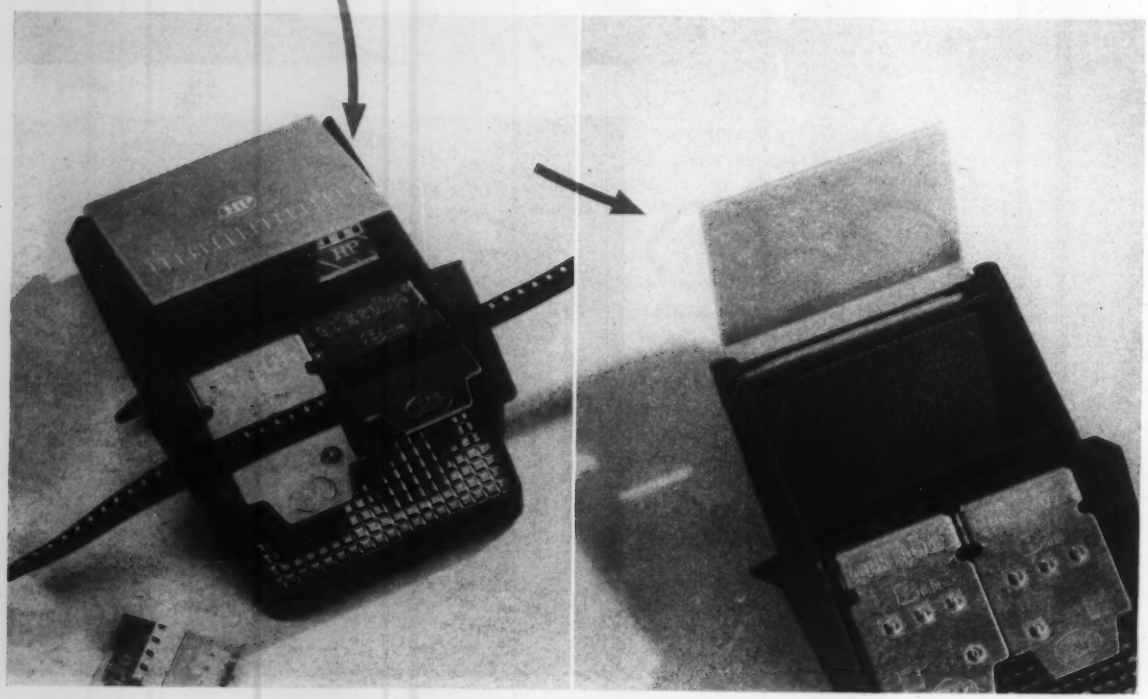

EXTRUSIONS are seldom used just as they come off the extruder. Cutting to length is necessary in almost all cases, and secondary fabrication is frequently needed. Holes may be drilled or punched, parts of the extrusion may be milled away, or forming operations may be necessary. Lettering may be printed or hot stamped. And the extrusion may be designed to provide integral assembly techniques. Here are some typical (and some unusual) examples.

34 An extruded dial scale, Fig. 34, made of translucent white acrylic, has integrally extruded mounting flanges (one mounting hole can be seen). This one-piece construction eliminates extra brackets and other mounting hardware, allows for uniform illumination of fine-detail printing from behind, and reduces total height necessary for the cabinet.

On high-fidelity tuners, the antenna must be mounted as far away as possible from the interfering electrical and magnetic fields of the set. At the same time, the fragile ferrite-antenna stick must be guarded from mechanical damage. Metal is out of the question because of its shielding properties, but ethyl cellulose or high-impact styrene are excellent materials which are transparent to radio-frequency waves. A 35 flanged split tubular extrusion, Fig. 35, provides the solution in a one-piece unit. The flange is fabricated with punched holes and cut-outs, while the extruded split in the tubular section allows the projecting lead-in wires of the antenna to be connected into the tuner circuit.

Complex, interlocking, fabricated extruded parts, as in 36 Fig. 36, can be extremely economical because of low tooling costs. Three different extrusions make up this nine-cell battery holder for a portable short wave radio: Two holder halves, plus thin extruded rods made of the same material (high-impact polystyrene). The rods are cut slightly longer than the actual battery holder case, and are subsequently heat-swedged over the fiber end pieces, similar to rivets. Cover snap-fits over the holder. This three-part plastic assembly is probably one of the most intricate extrusion jobs ever attempted.

37 An extruded plastic mounting strip, Fig. 37, mounts sensitive limit switches which control a textile machine. This strip has two precisely extruded recesses, *A* and *B*, to hold copper bus bars in place. The switches are screwed to the heavy center section of the plastic. Extrusion is high-impact styrene. Cut-outs at *C* and *D* eliminate excessive, useless material.

38 A movie-film splicer, Fig. 38, uses an extrusion as a cover for the splicing-tape supply compartment. The body of the splicer is a die casting with two integrally cast pins which snap into the keyhole-like recess in the extrusion, one at each end. Flat area of the gray plastic molding is silk screened with a trade mark and decorative design. Various-width covers are easily obtained by simply changing the cut length; only one extrusion die is required for a complete line of different splicers.

Grooving for Sleeve

Selection of type of groove, width, depth, and configuration for effective lubrication

SPECIFICATION of grooves for a sleeve bearing is equally as important as any other aspect of bearing design. Many cast-bronze sleeve bearings, properly designed otherwise, have been handicapped by improper or overzealous application of grooves. In some cases, the only reasons a grooved bearing functions at all are choice of a cast bronze as the bearing material and removal of excessive heat by the lubricant.

The primary purpose of grooving within a sleeve bearing is to expedite and insure distribution and maintenance of an efficient film of lubricant, either partial or complete, between moving surfaces of journal and bearing. How this purpose may best be achieved depends mainly upon the anticipated mode of operation—that is, whether the bearing is designed to operate under conditions of full-film, mixed, boundary, or hydrostatic lubrication. Other necessary considerations are:

1. Type of lubricant.
2. Lubrication system.
3. Nature of the load.
4. Relative motion of bearing members.

Grooving for Full-Film Lubrication

Full-film lubrication can be achieved with either oil or grease. However, greases are seldom used for this purpose since it is a chore to continually re-

Table 13—Uses of Grooving for Full-Film Lubrication

Type of Groove	When To Use	Comments
Single oil hole	When oil flow from single oil-inlet hole can provide sufficient lubricant.	Hole location depends on direction of load and may be in either bearing or shaft.
Straight-axial	For more effective axial distribution of lubricant, especially in long bearings.	Groove and inlet-hole locations depend on direction of load and may be in either bearing or shaft.
Feeder plus straight-axial	In large-diameter bearings to permit correct location of axial groove.	Sequence of groove elements, in direction of rotation, must be: 1. Oil hole. 2. Feeder groove. 3. Axial grove.
Circular	When direction of load varies such that a consistent low-pressure region cannot be located on either bearing or shaft.	Groove is usually pressure-fed.
Straight-axial circular	When circular groove cannot be pressure-fed.	Axial groove must be located in low-pressure region.

Bearings

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plenish the grease which escapes from the bearing. Hence, only grooving for normal lubricating fluid—oil—will be considered.

From previous discussions, full-film lubrication was shown to be possible under favorable conditions of load and speed, provided, of course, that the bearing is properly designed to promote separation of the bearing members. An approximation of oil-flow rate required to sustain hydrodynamic lubrication has also been discussed. Next, where to introduce the necessary lubricant must be determined. The obvious and only location for introducing lubricant to the bearing is in a region of low pressure.

Theoretical distribution of pressure within an ungrooved, full-film lubricated sleeve bearing is shown

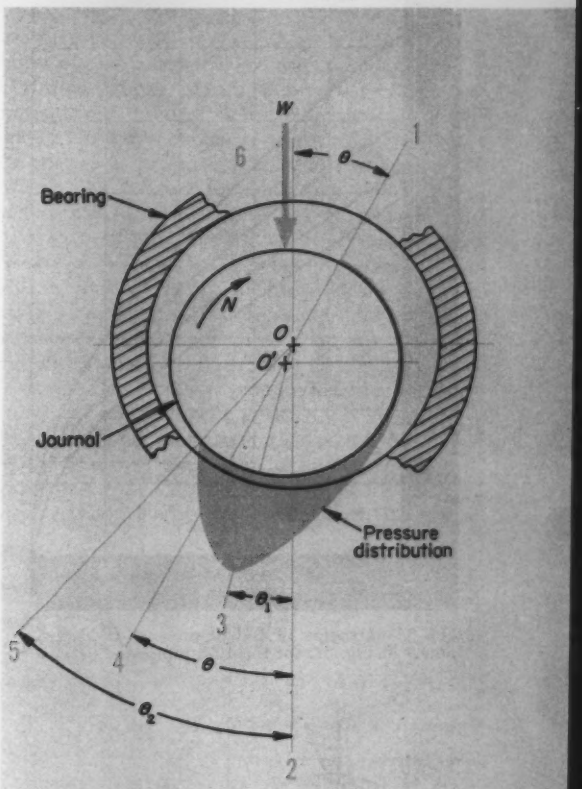


Fig. 32—Reference locations for pressure distribution within an ungrooved bronze bearing operating with full-film lubrication are: 1. Maximum film thickness; beginning of pressure formation. 2. Direction of load. 3. Maximum film pressure. 4. Minimum film thickness. 5. End of pressure film. 6. Unloaded side of bearing.

Nomenclature

A = Bearing characteristic number
a = Groove width, in.
b = Groove depth, in.
D = Journal diameter, in.
D_B = Bearing bore diameter, in.
L = Bearing length, in.
N = Rotational speed of journal, rpm
O = Actual center location of bearing
O′ = Actual center location of displaced journal
W = Steady load to be supported, lb
w = Wall thickness of bearing, in.
ϵ = Journal eccentricity ratio
θ = Angle between direction of load and direction of journal displacement, deg
θ_1 = Angle between direction of load and point of maximum film pressure, deg
θ_2 = Angle between direction of load and point where film pressure ends, deg

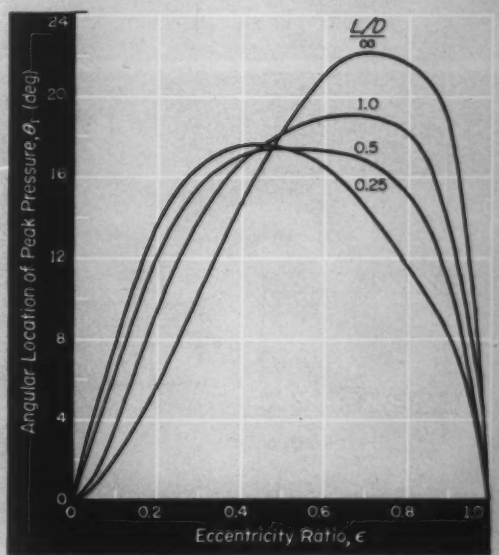


Fig. 33—Location of peak pressure, position 3 in Fig. 32, for full-film lubricated bearing.

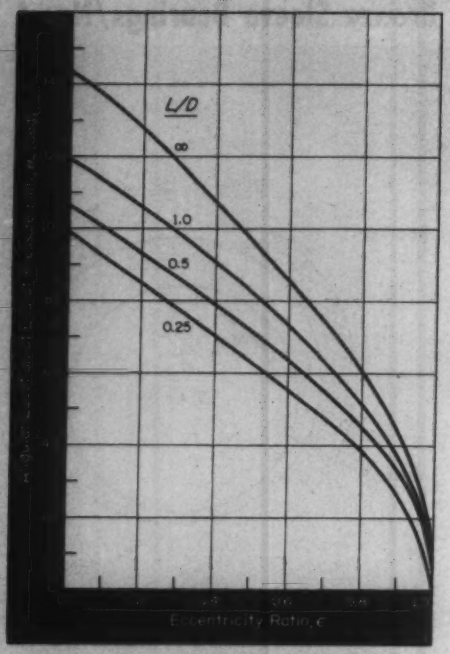


Fig. 34—Location of end of pressure film, position 5 in Fig. 32, for full-film lubricated bearing.

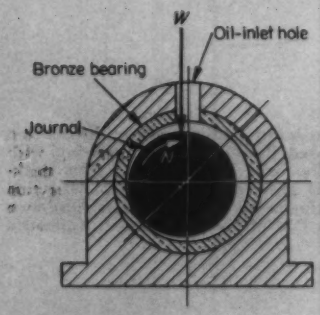


Fig. 35—Single oil-inlet hole located on unloaded side of bearing.

in Fig. 32. The numbered locations around the bearing are of interest and are referred to throughout this discussion. Pressure is generated, in a clockwise direction, from region 1 to 5, and the low-pressure region is from 5 to 1. Location 1 is the region of maximum film thickness and is diametrically opposite location 4, which is the region of minimum film thickness. Location 4 can be determined from the curves in Fig. 12 (in Reference 1). Location 2 is on a line through the bearing center and parallel to the direction of load. Peak pressure at position 3 and zero pressure at position 5 are located using position 2 as a reference. Fig. 33 and 34 can be used to determine locations 3 and 5 if the operating eccentricity ratio is known.

With three points on the pressure distribution curve known—zero at 1, maximum at 3, and zero again at 5—the pressure distribution can be approximated by connecting these three points as in Fig. 32. Location 6 is on the unloaded side of the bearing opposite location 2. If the journal were rotating in the opposite direction, the geometry would be reversed and could be obtained by looking at Fig. 32 in a mirror. Also, if the load were acting in some direction other than that shown, the proper picture could be obtained by rotating the figure until load W is in the proper angular position.

For the simple case where load is constant and always in one direction and the speed is also constant, the low-pressure region from 5 to 1 is always in the same location with respect to the bearing. Hence, the oil-inlet hole may be located somewhere between location 5 and, in the clockwise direction, location 1—the closer to 1 the better. Usual practice is to place the oil-inlet hole at location 6, Fig. 35. In horizontal bearings, the inlet hole should be centered axially; for vertical bearings, it should be closer to the top end.

In many cases a single oil-inlet hole located in the unloaded region of the bearing will suffice. However, if the bearing is of appreciable length, lubricant will not be distributed uniformly over the en-

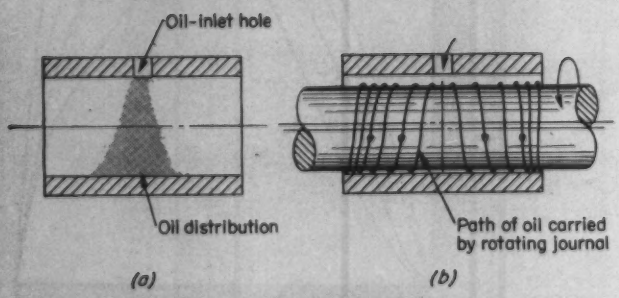


Fig. 36—Possible oil distribution in a long bearing using only a single oil-inlet hole.

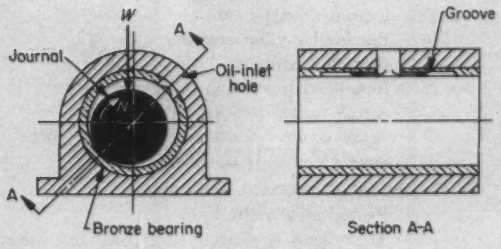


Fig. 37—Straight-axial oil distribution groove.

tire length of the bearing. Fig. 36*a* illustrates this condition. Possible route of travel of lubricant through the bearing is shown in Fig. 36*b* to further illustrate the point. To correct this situation, a straight-axial groove is often placed in the bearing, Fig. 37, usually at the same location as the inlet hole (position 6). When this type of grooving is used, the oil can be distributed axially along the groove before being picked up by the shaft and carried through the bearing. A much more uniform distribution of lubricant is thus made possible over the length of the bearing. This type of grooving shall be designated a "straight" groove.

If the bearing is fairly large in diameter, the straight-axial distribution groove should be located closer to position 1. This location, Fig. 38, allows the lubricant to be picked up by the shaft closer to the point where it is needed. If it is impossible to position the oil-inlet hole directly above the axial distribution groove at position 1, the inlet hole may be connected to the distribution groove by a feeder groove, Fig. 39. Remember, however, that the oil-inlet hole must be located only in the low-pressure region. Orientation of the grooves with respect to direction of shaft rotation is also important. That is, a point on the shaft should arrive first at the oil-inlet hole, then at the partial circumferential-feeder groove, and finally at the straight-axial distribution groove.

Thus far, only unidirectional loading and rotation have been considered, and required grooving is very simple. For such operating conditions, all that is required is to establish the location of the low-presssure region of the bearing and use either a single oil hole or a straight grooving arrangement in this region. The pressure distribution can be approximated by first evaluating the probable eccentricity ratio from Fig. 13 (in Reference 1). Position 4 and, hence, position 1 can then be determined from Fig. 12 (Reference 1). The other two points of interest on the pressure distribution curve are points 3 and 5, which are determined from Fig. 33 and 34 for the same eccentricity ratio.

Location of the generated pressure within a full-film lubricated bronze bearing depends upon bearing characteristic number *A* and the directions of load and speed. Any change in operating conditions means a change in pressure distribution which must move within the bearing for continued satisfactory operation. Consequently, it may not be possible to locate a region of the bearing which is always at low pressure. For example, in a bearing where load may fall in any direction, a given location may alternately be in a high-pressure region and then in a low-pressure region, depending upon instantaneous load direction. To allow for this condition, a circular or annular groove is usually machined completely around the bearing, Fig. 40.

The circular type of groove divides the bearing into two shorter bearings, each of which is lubricated from one end. Other conditions being equal, two short bearings whose combined length is equal

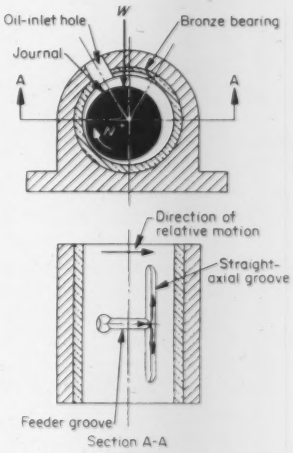


Fig. 39 — Oil-inlet hole joined to properly located straight-axial groove by a feeder groove. To aid machining, feeder groove may extend slightly beyond the straight groove or inlet hole.

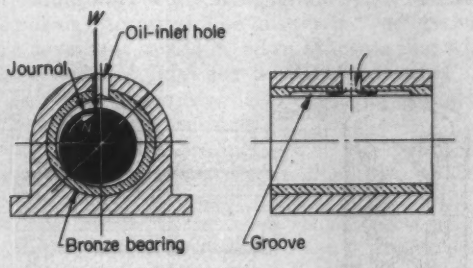


Fig. 38—Straight-axial groove and inlet hole located at beginning of generated-pressure zone for better oil distribution.

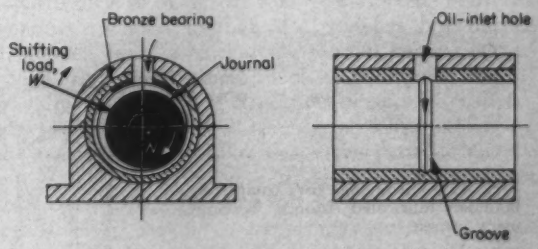


Fig. 40—Circular oil-distribution groove for load with constantly changing direction.

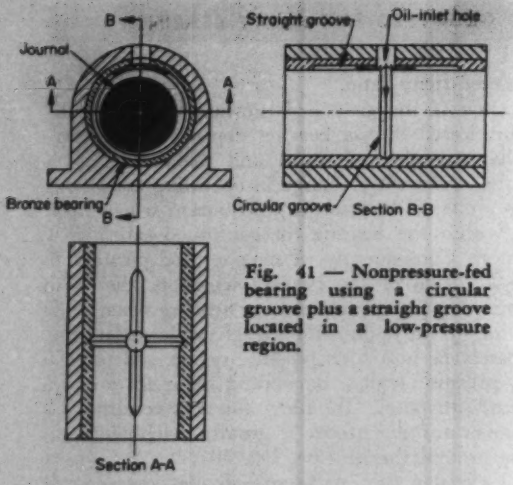


Fig. 41 — Nonpressure-fed bearing using a circular groove plus a straight groove located in a low-pressure region.

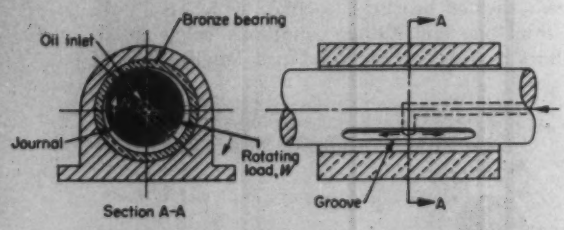


Fig. 42—Oil inlet and straight-axial groove located in low-pressure region of shaft for synchronous rotating load.

to that of a single bearing do not carry the same load as the single bearing. Thus, each half of the bearing has to be treated separately to evaluate load-carrying capacity, eccentricity ratio, etc. The oil-inlet hole can be at any angular position around the bearing. Actually, the circular groove could just as easily be put in the shaft if shaft strength permits. Also, the oil-inlet hole could be put in the shaft if supplying lubricant through the shaft is desired.

Circular-grooved bearings are usually pressure-fed. However, they may be used in nonpressure-fed applications in combination with a straight-axial groove if the straight groove is placed in a relatively lightly loaded region of the bearing, Fig. 41. If the lightly loaded region is fixed with respect to the shaft, the straight groove may be machined in the shaft. This type of grooving shall be designated a combination circular and straight-axial groove.

For the special case in which load rotates with the shaft, either a single hole or a straight groove or both may be used in the shaft. Lubricating through the shaft is possible with a synchronized rotating load because the pressure distribution is fixed with respect to the shaft. Here again the oil-inlet hole and groove in Fig. 42 must be oriented to lie between positions 6 and 1 just as was necessary when the inlet hole and groove were in the bearing. This type of grooving is also recommended when the bronze bearing rotates around a stationary shaft.

For ring or chain-oiled bearings, a slot at the

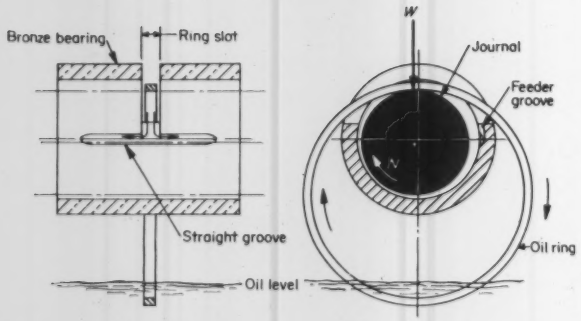


Fig. 43—Ring-oiled bearing using feeder and straight-axial grooves to distribute oil picked up by ring.

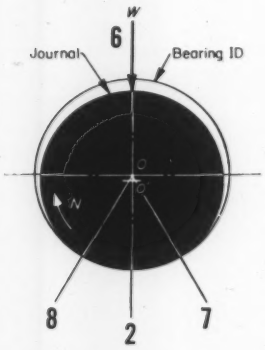
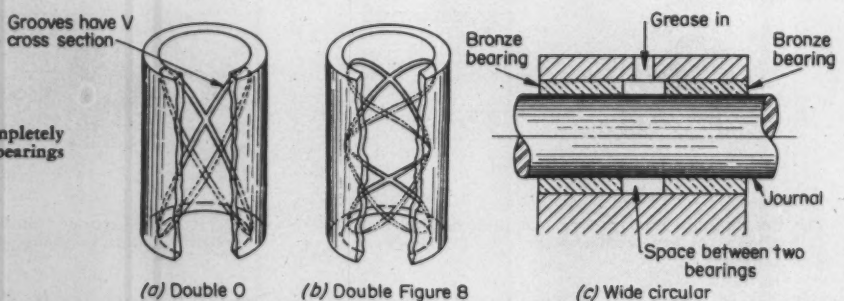


Fig. 44 — Geometry of completely boundary-lubricated sleeve bearing.

Fig. 45 — Grooving for completely boundary-lubricated bronze bearings using grease.



top of the bearing allows the ring or chain to touch the rotating journal. The slot is usually connected to a straight distribution groove by a feeder groove, Fig. 43. Orientation of the grooving should be as indicated. Recommended total clearance between ring and slot is $\frac{1}{16}$ to $\frac{1}{8}$ in.

Preferred types of grooving for full-film, hydrodynamically lubricated sleeve bearings are summarized in Table 13. In general, for vertical bearings the oil-inlet hole is displaced from the axial center of the bearing to a position closer to the top of the bearing. Circular grooves, when used, are also usually displaced toward the top of the bearing.

In some cases a sleeve bearing may receive lubricant from one end of the bearing. To provide effective lubrication, the oil must first enter and then pass through the bearing. Small clearances and the internal pressures generated normally prevent axial flow through the bearing. However, one way of promoting flow through the bearing is to provide a straight-axial groove which is located in the low-pressure region and which is open at the lubricant end of the bearing.

Performance of some full-film lubricated bronze bearings can at times be enhanced by some form of specialized or "exotic" grooving different from the types already covered. However, the designer should consider carefully before specifying such forms. Not only are special grooves expensive to fabricate, but more important, they may defeat their purpose by crossing regions of the bearing which would otherwise generate load-carrying pressure. If the necessary pressure distribution for full-film lubrication can be determined, special grooving may be used in the low-pressure region to suit a particular application. However, specialized grooving should be considered only if one of the previously discussed types cannot be used or is not adequate.

One final and important requirement is that the edges of all grooves be broken or chamfered at assembly after the bore of the bearing is finished or sized. This precaution eliminates the possibility of having burrs on the grooves which would act as oil scrapers.

▶ Grooving for Complete Boundary Lubrication

By definition of complete boundary lubrication, none of the load on the bearing is supported by lubricant. Consequently, the question might be asked: Is grooving necessary? The answer is "yes" because every advantage should be taken to insure that what little amount of lubricant is provided reaches the loaded region of the bearing to effectively boundary lubricate the moving surfaces.

Normally, sleeve bearings which are lubricated only periodically will at some time be operating under boundary lubrication conditions. For such applications, grease is the more usual lubricant although hand-oiled bearings fall into a similar category. Since grease does not flow readily, it must be pumped into the bearing. Inside the bearing, grooves are necessary to allow free passage of the grease to the loaded region and to provide a reservoir for the grease. When oil is used for completely boundary-lubricated bearings, grooving allows easy passage of the lubricant to the region where it is required. Grooving also acts as a trap for the oil and retards its eventual escape from the bearing.

Thus, the little lubricant that is supplied under boundary lubricating conditions remains within the bearing longer than it would if there were no grooving, provided, of course, that the grooves do not break through the ends of the bearing. One other beneficial effect of grooving is that a convenient trap is provided for wear particles and other foreign matter which might otherwise enter the bearing.

Geometry of a completely boundary-lubricated journal operating within a sleeve is shown in Fig. 44. Under action of applied load, the journal will always bear against the bearing in the direction of load regardless of the magnitude of load and speed or the direction of motion of the shaft. Thus, the loaded region would be at position 2 as shown in Fig. 44. Load-carrying area, or area of contact, will lie between positions 7 and 8. Since the bearing cannot generate hydrodynamic film pressures under complete boundary lubrication because a continuous supply of lubricant is lacking, no harm can be done by grooves which pass through the load zone. However, removal of too much bearing material should be avoided to prevent excessive unit pressures in the load zone.

Two types of grooves acceptable for completely boundary-lubricated bearings using grease are shown in Fig. 45*a* and *b*. These grooves, while appearing to be complex, are easily generated on a grooving machine—an important fabricating consideration. Similar groove configurations may be used when oil is the lubricant. Notice that these grooves do not break through the ends of the bearing.

Another simple but good groove for grease lubrication is the arrangement in Fig. 45c. The wide circular groove can be obtained merely by allowing a gap to exist between two bearings in the same housing to provide a generous grease reservoir. The same effect could be achieved by cutting a wide circular groove in the shaft.

▶ Grooving for Mixed-Film Lubrication

Geometry of a mixed-film lubricated bronze bearing is similar to that of a complete boundary-lubricated bearing in that the journal bears against the bearing in the direction of load, Fig. 46. However, for this situation a portion of applied load is supported by fluid pressures generated in local areas of the load zone. Likewise, some metal-to-metal contact occurs in region 7 to 8. When mixed-film conditions exist, this area of contact is somewhat smaller than that for a completely boundary-lubricated sleeve bearing. In fact, contact area is quite small unless some wearing-in has occurred.

Previous definition of mixed-film conditions states that the bearing must be supplied continuously with lubricant and that the lubricant must be picked

up by the shaft and carried to the load zone before escaping from the bearing. Use of grooves in the load zone should also be avoided for this type of lubrication. Recommended grooves for mixed-film operation are the same as for full-film lubrication except that the oil should be picked up by the shaft at a point closer to the region of minimum film thickness, location 4 in Fig. 32. If load is continually changing direction, an axial groove, or even just a single hole, may be used in a relatively lightly loaded region.

Groove Dimensions

Common groove cross sections are shown in Fig. 47. The V-groove is generally recommended from a fabrication standpoint. Specifying chamfered corners at the bearing surface, as indicated on the V-groove in Fig. 47, is an important detailing practice. This step is necessary in all grooving so that lubricant which adheres to the rotating shaft is not wiped off by burrs or projections at groove corners. However, chamfered corners are not as critical for boundary-lubricated bearings. Inside corners at the bottom of grooves should be rounded to avoid local stress concentration.

Width and Depth: Recommended groove widths and depths for various bore diameters are given in Fig. 48 and are the same for all oil grooving regardless of groove configuration. Width curve *a* is plotted in 1/32-in. increments since groove width is not critical and need not be specified to a closer tolerance. Also, groove depth *b* need not be specified any closer than the nearest 1/64 in.

Before groove depth from Fig. 48 is specified, value *b* should be compared with 1/3 the wall thickness of the bearing material. If the value of $w/3$ is less than *b*, then $w/3$ should be specified as the groove depth. On the other hand, if *b* is less than 1/3 the wall thickness, then the value of *b* should be specified. If groove depth is always kept less than 1/3 the wall thickness, the bearing is not unduly weakened at the location of the groove.

When grease is used as the lubricant, the groove should be widened somewhat to provide free passage for the less-mobile grease. For this purpose, groove width may be increased up to 1.5 times the values recommended for oil in Fig. 48.

Configuration: Dimensioning of groove configuration, or plan view, will depend upon type of grooving used and size of the bearing. As a general rule, grooves should not break out the ends of the bearing unless the bearing is to be lubricated from one end. However, grooving may approach the bearing ends. Recommended distance between groove and end of the bearing should be more than 0.05 times the length of the bearing, Fig. 49*a* and *b*. For short bearings, minimum distance from end of the bearing to grooving should be $\frac{1}{8}$ in.

Oil-inlet holes should, as has been stated, be located in the low-pressure region of the bearing.

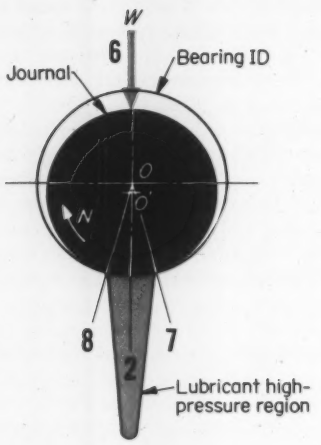


Fig. 46—Geometry of mixed-film lubricated sleeve bearing.

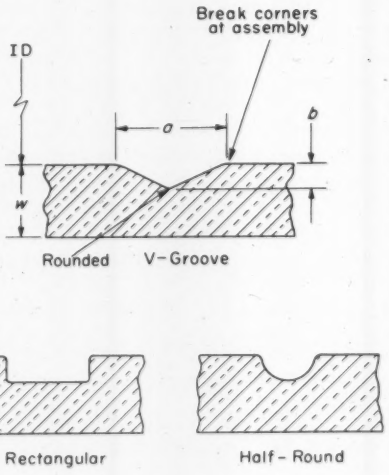


Fig. 47—Typical grooving cross sections for bronze bearings. The V-groove is generally easier to machine and develops a better lubricating film.

If used in conjunction with grooving, inlet holes should be centered about the groove. Size of the inlet hole should be at least as large as the width of the groove it is supplying and preferably 1.5 times groove width for the smaller size bearings. For vertically mounted bearings, the oil-inlet hole should be located closer to the top to help equalize oil flow. In nonpressure-fed applications, the inlet hole should

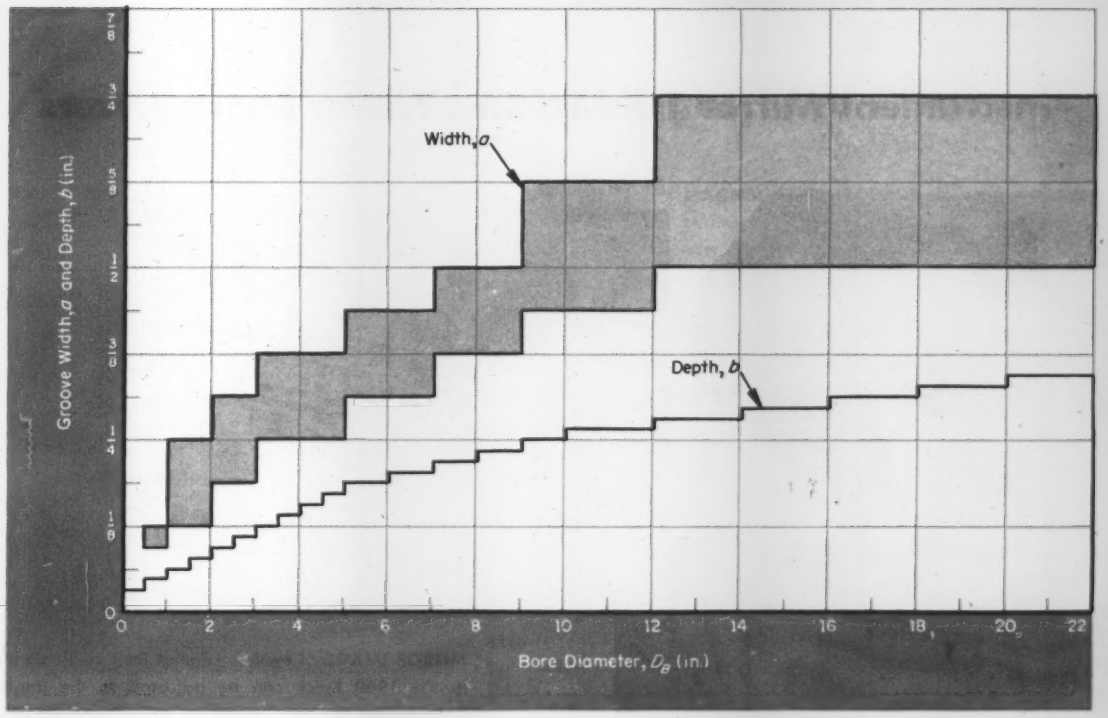


Fig. 48—Recommended groove dimensions for oil-lubricated bronze bearings. For grease-lubricated bearings, increase groove width up to 1.5 times values given.

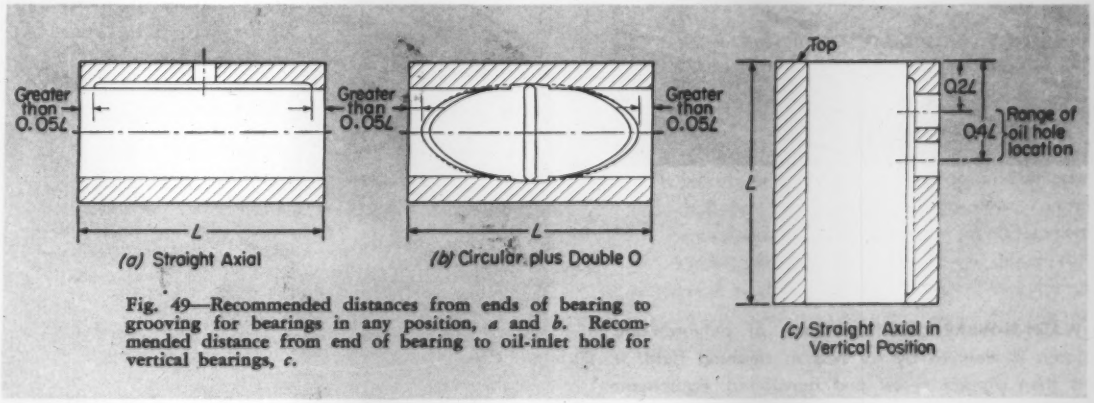


Fig. 49—Recommended distances from ends of bearing to grooving for bearings in any position, *a* and *b*. Recommended distance from end of bearing to oil-inlet hole for vertical bearings, *c*.

be located approximately within the range shown in Fig. 49c.

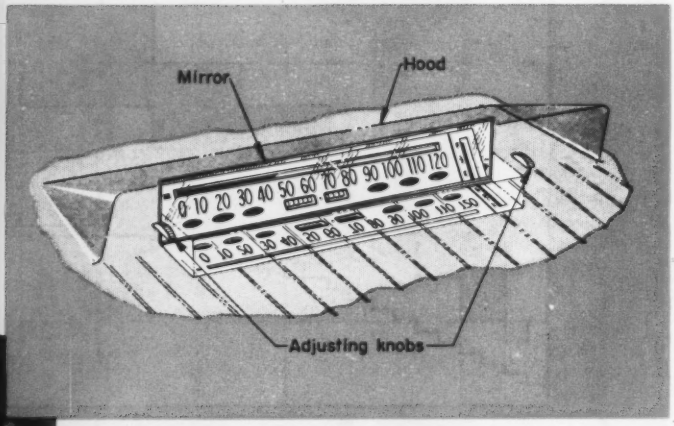
Next article will discuss how the method of applying lubricant affects oil flow to a bearing. Flow rates for pressure-fed bearings are determined by groove configuration and can be calculated. Oil flow rates for nonpressure-fed applications are also covered.

REFERENCES

This is the fourth in a planned program of six articles which will present a complete Design Manual sponsored by Cast Bronze Bearing Institute. Issues of MACHINE DESIGN in which previous articles appeared are:

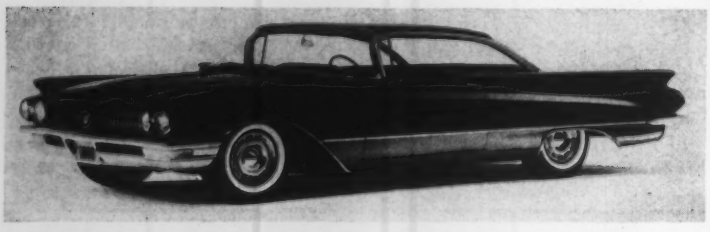
1. "Bronze Sleeve Bearings" ..... September 17, 1959
2. "Viscosity and Lubricants" ..... October 1, 1959
3. "Sleeve-Bearing Bronzes" ..... October 29, 1959

Instrument Mirror Tilts To Suit Tall or Short Drivers



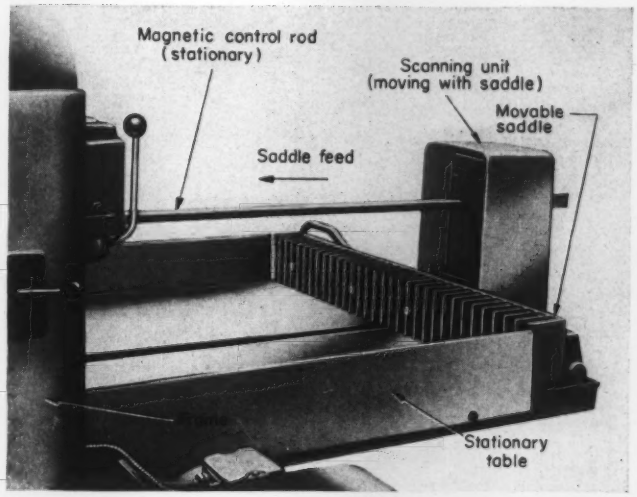
MIRROR IMAGE of reverse-printed instrument panel in the 1960 Buick can be adjusted to the angle best suited to the height of the driver. Plastic knobs at each end of the panel well tilt the mirror to the desired angle.

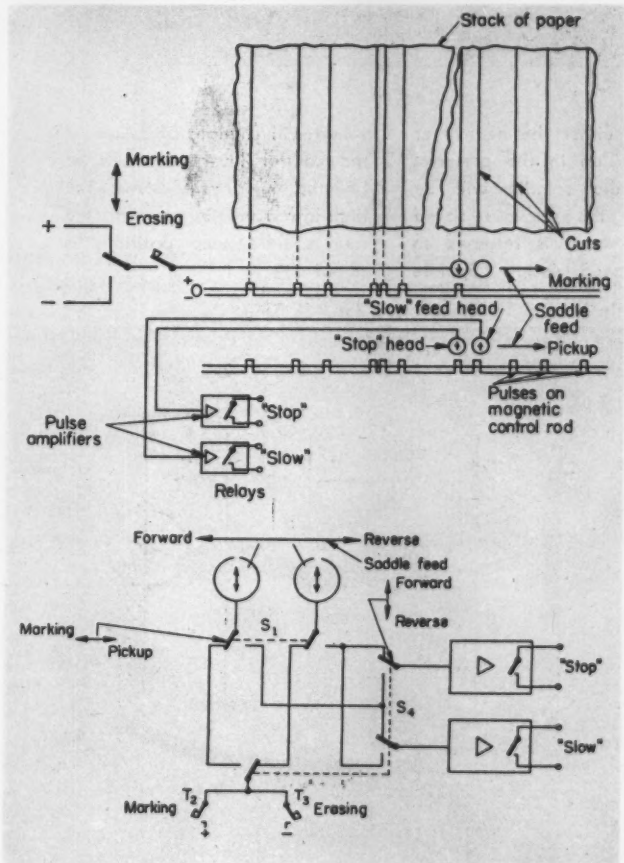
WASH-N-WEAR air filter made of polyurethane foam is cleaned by flushing in cleaning fluid. It is then dipped in oil and reinstalled. Equipment is available for 1960 Buick.



HEADLIGHTS GO ON at dusk in response to a signal from a sky-oriented electric eye. Return of daylight turns off the lights. A time delay prevents switching of lights each time the car goes under a streetlight.

Tape Pasted on Rod Stores Eight Feed Programs





MAGNETIC CONTROL ROD, located above the stationary table of a paper cutting machine, acts as a "magnetic ruler" to mark stop feed positions for paper cutting operations. The ruler consists of magnetic tape pasted onto a plastic rod. Scanning unit, moving with the paper-feed saddle, carries two magnetic reading heads which control feed motor and electromagnetic clutches. A shifting mechanism positions the magnetic heads on any one of eight independently marked tracks. Saddle and scanning unit move at approximately 6-ips speed. As the first reading head reaches a magnetic mark, corresponding relay actuates clutches, switching saddle to slow feed. This arrangement permits the saddle to stop instantly as soon as "stop" head reaches recorded mark. After the stack of paper has been clamped and cut, saddle is again advanced at "high" speed. Rod is programmed by moving saddle assembly to desired position and pulsing the "stop" head to record a magnetic bit at the appropriate rod position.

MOVABLE SADDLE, operated by feed motor or adjusted manually through handwheel, pushes stack of paper along table, stops for knife cut at preset positions. Control panel includes pushbuttons for marking, pickup, and erasing, for forward and reverse, and for track selection. Magnetic control equipment is a development of Telefunken GmbH, Wedel/Holst, Germany. Paper cutter is made by Rheinische Papierbearbeitungs -Maschinenfabrik GmbH, Loevenich/Cologne, Germany.

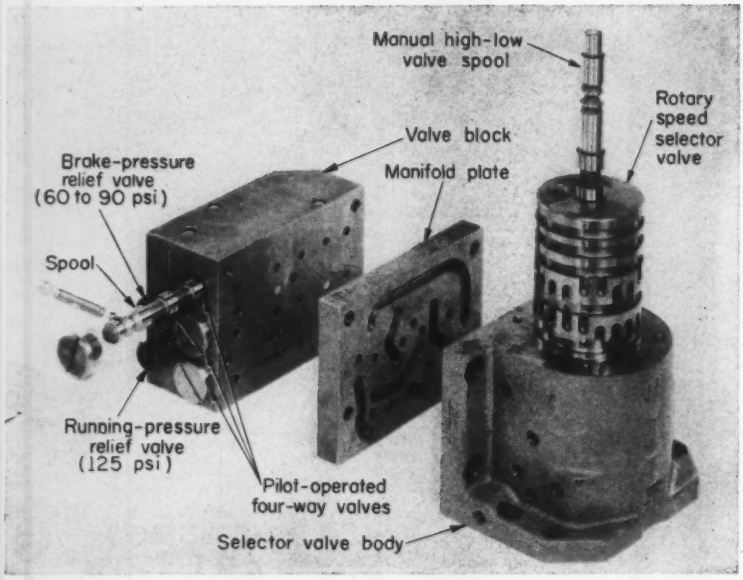
REVERSIBLE CIRCUIT permits scanning unit to control saddle feeds in either forward or reverse. During forward feed, magnetic head arriving at recorded mark first is designated "slow feed" head and actuates the "slow feed" relay. Head arriving later ("stop" head) actuates the "stop" relay. For reverse control, head functions and relay connections are reversed correspondingly. Marking and erasing is possible in both forward and reverse through pushbuttons acting on respective "stop" heads.

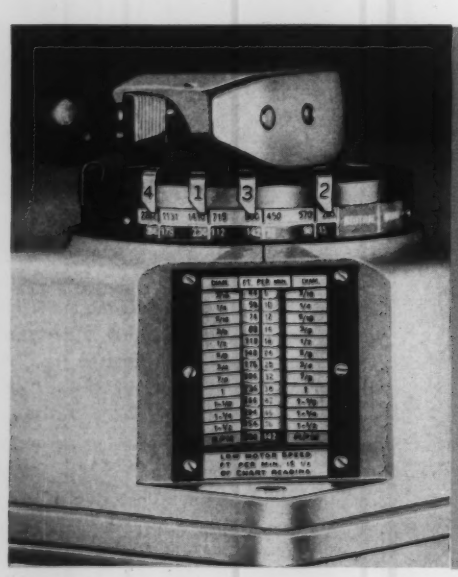
Combination Rotary and Spool Valve Sets

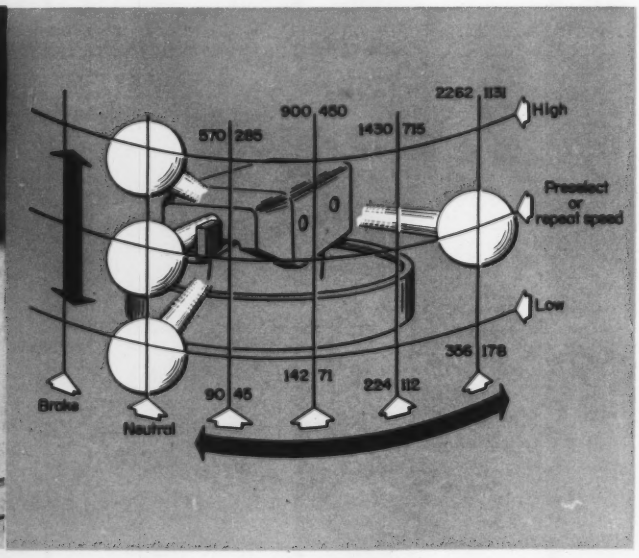
SINGLE-LEVER SELECTOR VALVE controls six hydraulically operated clutches in a machine transmission. The combination rotary valve and spool valve was designed by engineer Al McClelland, Warner and Swasey Co., for application in their new No. 3 Universal turret lathe. The control unit is designed with a direct-reading preselector dial which indicates surface speed produced at various listed diameters by the spindle speed at which the selecting lever is set.

Speed preselection is accomplished by moving the control lever horizontally to the left or right. Speeds can be preselected while the spindle is running. Machine drive speed is changed by raising or lowering the control lever to the appropriate speed position.

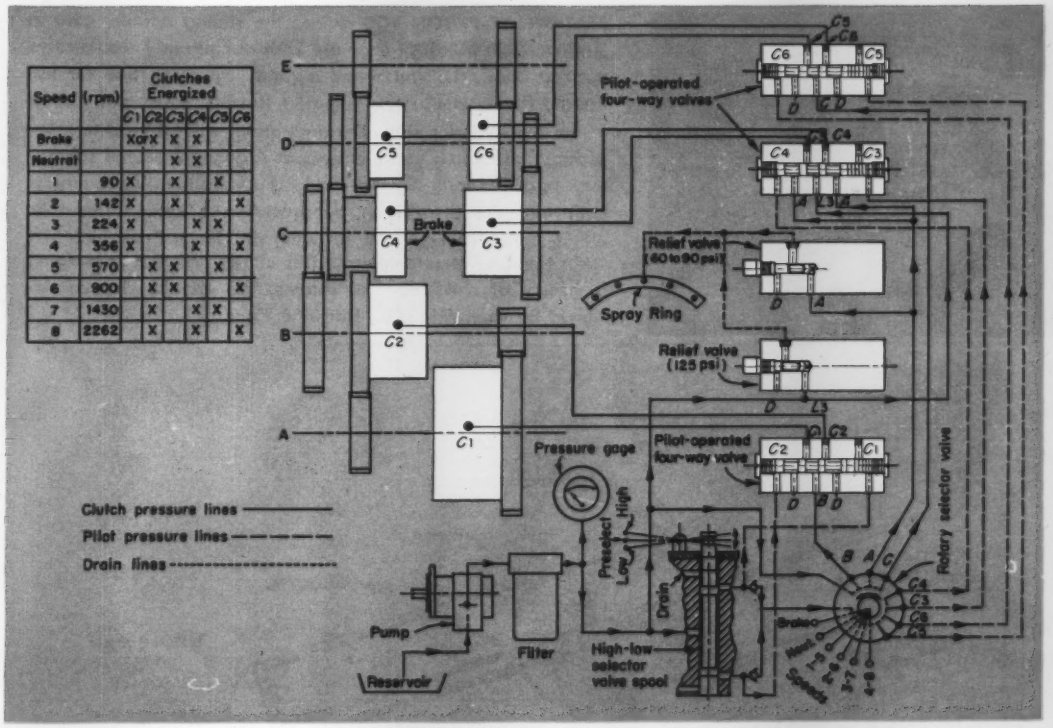
The speed control is designed to retain a previous setting as long as the control lever is kept in the "preselect" or center channel. Thus, if the control is moved to either the neutral or brake position in the preselect channel, the spindle will be driven at the previous speed when the lever is returned to spindle speed sector. Spindle speed will change, of course, if the control lever is raised or lowered in any position. The high-low ratio in any of the four spindle-speed positions is about 6½ to 1.





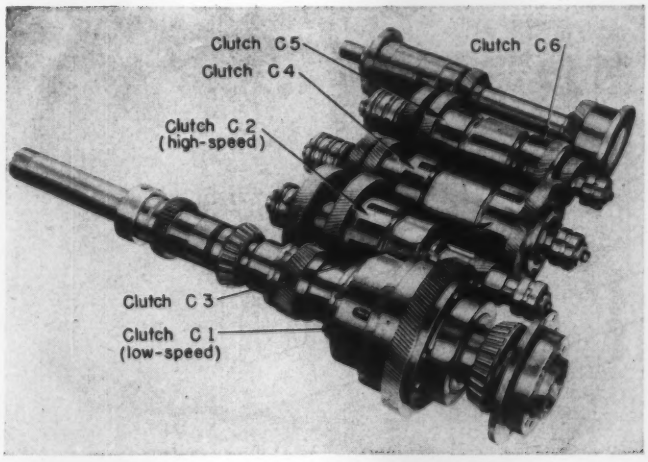


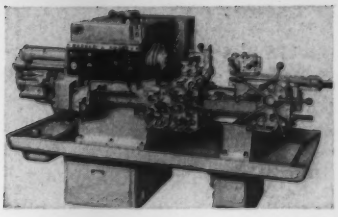
Eight Speeds Plus Neutral and Brake



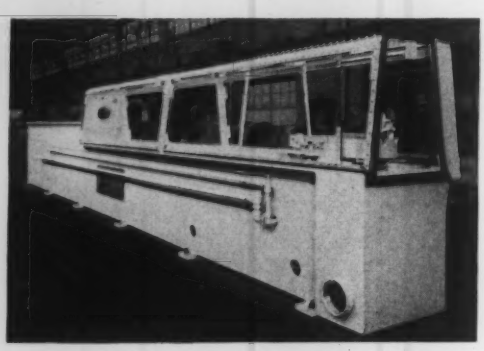
HIGH OR LOW SPEEDS of operation are determined by whether clutch C1 or C2 is energized. The spool section of the selector valve controls clutches C1 and C2 through the pilot-operated, four-way valves. The rotary section of the valve controls clutches C3, C4, C5, and C6 through the four-way valves.

As shown in the speed chart, three clutches must be energized to produce any one of the eight drive speeds or braking action. With a two-speed electric drive motor, 16 speeds are available.

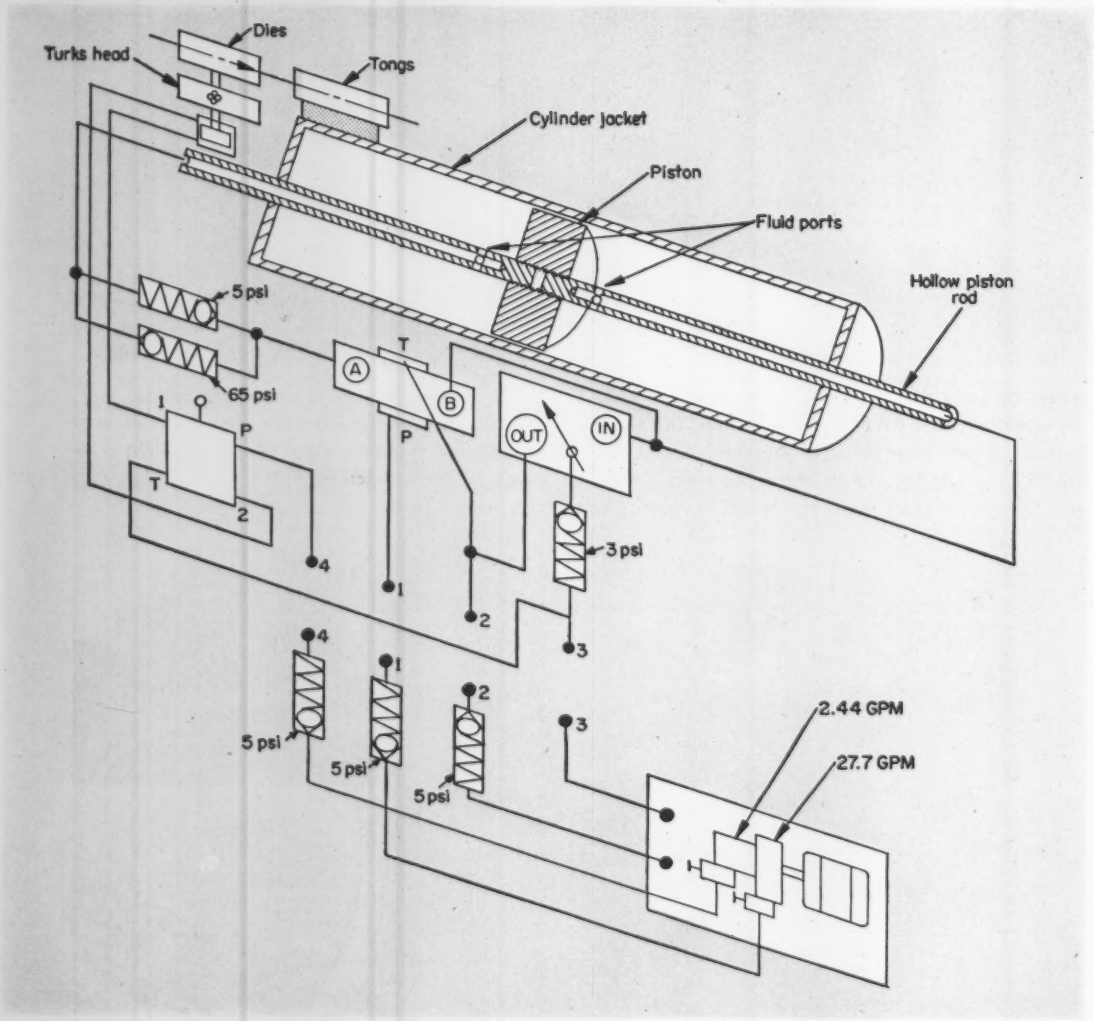




Hollow Rod Triples as Guide Rail, Line, and Piston Rod



STATIONARY PISTON ROD guides the sliding cylinder case in a drawbench developed for use with dangerously radioactive nuclear fuels. The rod forms a rigid, one-piece line for hydraulic fluids, eliminating exposed flexible hoses and fittings in the thin cylinder wall. The drawbench will be used to manufacture plutonium fuel elements at Argonne National Laboratory and Hanford Atomic Products Operation. Versatility is built into the drawbench by providing a second hydraulic cylinder that changes the drawing die for a Fenn No. 3TH Turks Head by remote control. This allows drawing or swaging a variety of cross-sectional shapes. The drawbench was designed by Fenn Mfg. Co., Hartford, Conn.



Thermal Stresses in Design

Part 15 — Strain Gage Applications

Elastic Range Plastic Range

S. S. MANSON
Chief, Materials and Structures Research Div.
Lewis Research Center, NASA
Cleveland, Ohio

Nomenclature

A = Area, sq in.
ΔA = Increment of area, sq in.
E = Modulus of elasticity, psi
I = Moment of inertia, in.^{4}
r = Radius, in.
T = Temperature, F
ΔT = Change in temperature, deg F
t = Tangential distance, in.
x, y, z = Direction distances, in.
α = Coefficient of expansion, in./in./deg F
ϵ = Strain, in. per in.
μ = Poisson's ratio
τ = Shear stress, psi
σ = Stress, psi

Subscripts:

c = Cold condition
e = Elastic component
e_l = Elastic
h = Heated condition
i, j = Station or element
l = Longitudinal
p = Plastic component
p_l = Plastic
r = Radial
res = Residual
t = Tangential
x, y, z = Directions

THE MOST versatile tool for measuring thermal stresses is the resistance strain gage. Selection of gage materials and details of application techniques have been discussed in a previous article.[14] This article presents examples of numerous gage applications in actual design problems.

In all cases, the strain gage measures strain, and stress is deduced indirectly. Applications discussed in this article cover both the direct measurement of strain at the temperature involved, and the indirect deduction of strain in one temperature range from measurements in another more convenient temperature range.

Low Temperatures

There is little reason why strain gages should not be used to measure thermal stresses at very low temperatures. Commercial strain gages have been found suitable for strain measurements at temperatures as low as −300 F.[15] No extensive measurements of thermal stresses have, however, been reported at temperatures below room temperature. Hence, for the illustrations used, "low" is defined as the region between 40 to 140 F.

An interesting application of thermal-stress meas-

[14] References are tabulated at end of article.

urement in the room-temperature range involves a seagoing-vessel hull structure.[16] The submerged portion of the structure maintains a temperature close to that of the water, which changes relatively little during the course of the day. Regions above the draft are, however, exposed to solar radiation. Hence, the diurnal temperature variations are considerable. For example, during a summer day, the deck may range between 50 and 130 F. Differential expansions between the various regions give rise to thermal stresses.

Many refinements can be added to the method of calculation of these stresses. However, in the simplest approach, the ship is considered a beam, and the stresses are computed according to Equation 39.[7] This equation accounts for only the longitudinal stresses along the length of the ship. The ship is divided into small but finite elements. Equation 39 becomes

$$\sigma_{l,i} = -E\alpha T_i + \frac{\alpha E}{A}\sum T_j(\Delta A_j) + \frac{E\alpha}{I_z} y_i \sum T_j y_j(\Delta A_j) + \frac{\alpha E}{I_y} z_i \sum T_j z_j(\Delta A_j) \qquad (112)$$

where $\sigma_{l,i}$ is the longitudinal stress at the ith element, at distances y_i, z_i from the centroid of the cross section, and the j summations are taken over all of the elements into which the cross section is divided. Symbols I_y and I_z represent the moments of inertia of the cross section about the principal axes. In this way, all the metal in the transverse section including coamings, bulwarks, and bilge keels are included in the computation. However, whether or not this simplified approach will yield stress values sufficiently accurate for structural analysis must be determined.

Strains induced by the thermal stresses at a large number of surface points in the cross section of the hull were measured. The gages were not mounted directly on the ship plate. Instead, they were mounted on both sides of steel straps, and readings were added electrically to eliminate bending effects. The straps were bolted with pre-tension to the ship plate which eliminated the need for curing the gages on the massive hull. Above the draft line, straps were mounted on both sides of the ship plate to eliminate the bending component within the plate. Below the draft line, two straps were also used at each station. Both plates were mounted inside the ship, at slightly different heights above the plate surface. Hence, the strain at the centerline of the plate could be obtained by extrapolation of the two readings.

Temperature-compensated dummy gages were mounted at each location. Constant temperature at each gage station was insured by packing the gages with grease where they contacted the ship plate. At many locations three gages were mounted in a rectangular rosette to determine the principal stress directions and true longitudinal stress.

Sample results are shown in Fig. 87. The vertical crosses represent strain-gage stations. The lines joining the crosses form an outline of the central cross section of the hull and decks. The lines joining the solid data points are temperature changes at the test stations. At the reference time the ship's orientation and relation to the sun are shown in the inset. For the vertical portions of the hull, the temperature scale is horizontal. For the deck and bottom, the temperature scale is vertical. Experimentally determined stresses are shown by the open circles. Computations of stresses from Equation 112, based on the temperature measurements, are shown as the dot-dashed lines.

Moderate Temperatures

Measurements taken to verify the energy calculation method of solution involved temperatures up

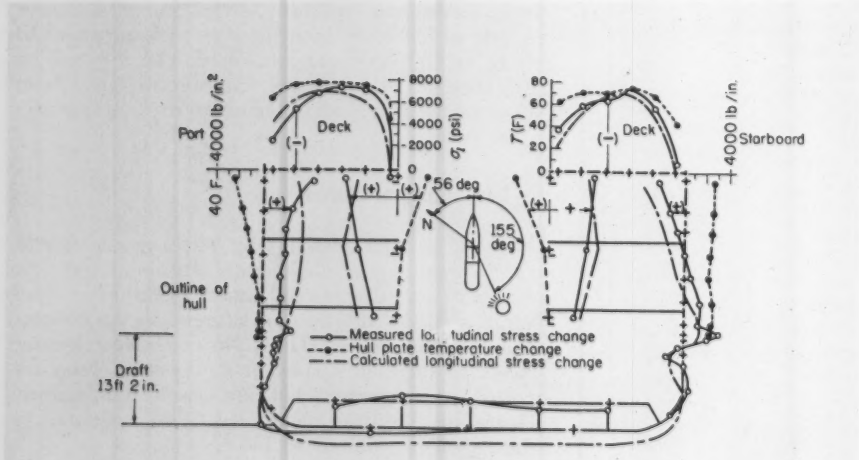


Fig. 87—Comparison between computed and measured thermal-stress distribution in ship hull.

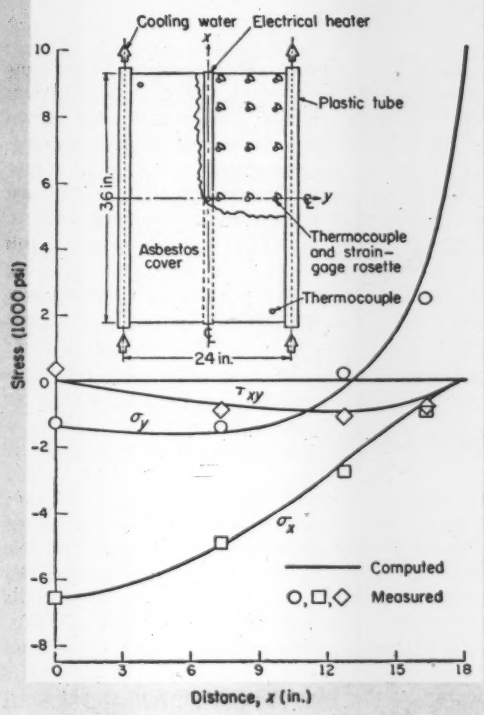


Fig. 88—Comparison between measured and computed thermal stresses in a plate which is centrally heated and edge-cooled at $y = 1.5$ in.

to approximately 300 F.[17] Hence, commercial Baldwin Type AB-7 gages could be used.

Automatic temperature compensation was not attempted. Instead, each gage was individually calibrated under stress-free conditions to determine the apparent strain due to temperature changes alone. The test plate and all its mounted gages were placed into a furnace and the temperature of the entire assembly was gradually and uniformly raised. Readings due to temperature alone were subtracted from the total readings involving thermal stresses.

The test condition chosen for verification of the analysis was a tentlike temperature distribution in a 36 by 24 by ¼-in. plate of 75-S-T6 aluminum alloy. A heating wire was cemented to the center of the plate parallel to the 36-in. dimension. Coolant tubes were cemented at both edges, parallel to the heating element. Hence, temperature was a maximum at the center of the plate and decreased approximately linearly toward both edges. Temperatures were recorded at each gage location and gage readings were corrected. The proper elastic modulus was used in the stress computations. The elastic moduli, as a function of temperature, were determined by direct load calibration of the plate itself. Gages were mounted on both sides of the plate, and the results averaged to obtain center-plane strains. At each gage location, three gages were mounted on each side of the plate, so the principal directions and strains could be computed.

Fig. 88 shows a comparison between the stresses determined by measurement and by computation. The curves represent computations of σ_x, σ_y, and $\tau_{x,y}$ as functions of x for $y = 1.5$ in.

High Temperatures

The high-temperature range must be divided rather sharply between cases involving temperatures no higher than 800 F, and those above this value. Up to 800 F, Karma gages are suitable for static measurements. At higher temperatures, other resistance materials, such as Nichrome V which unfortunately also has a high thermal coefficient of resistance, must be used. A high-temperature gage on the actual working part may be the best approach, particularly if temperature-compensation techniques are used.[14] In an alternate approach, the temperature distribution is retained, and the temperature level reduced so the temperature does not exceed 800 F at any point. Since thermal stresses depend primarily on the shape of the temperature distribution and not on the temperature level, these stresses can be determined at the more convenient temperature level. This approach neglects, however, the effect on the stresses due to changes in elastic moduli at the higher temperatures. This method is particularly in error if plastic flow occurs at the higher temperature, but does not occur at the lower temperature levels because of the higher yield points. Application to problems involving plastic flow are discussed later. Such a simplified analysis at the lower temperature level provides a good first approximation of the stresses at the high temperatures, and indicates whether plastic flow is likely to occur.

A typical application of the concept of reducing the temperature level but retaining the temperature distribution is an aircraft gas-turbine stator vane.[18] The maximum temperature in the vane was in the vicinity of 1700 F, which was too high for the Karma wire gages used. Thus, an experimental setup was devised in which electric heating and air cooling were used to subject each point in the vane to a temperature 1060 F less than the operating temperature in the engine. The success in achieving this temperature simulation is shown in Fig. 89.

Measurement of the stresses was accomplished using specially wound 0.001-in. diameter Karma gages mounted with Quigley 1925 cement on the surface which was precoated with L-6AC ceramic. Since the Quigley cement is somewhat hygroscopic, a coating of Plastilock was used where there was prolonged exposure to humidity at room temperature. The Karma lead wires were used, and the entire installation was thermally cycled, raising the temperature to the maximum value encountered in the test, to stabilize the gages.

Three sets of tests were conducted, each set involving gages oriented in a different direction at each location. Hence, each location was tested with the component of a rectangular rosette. Computations

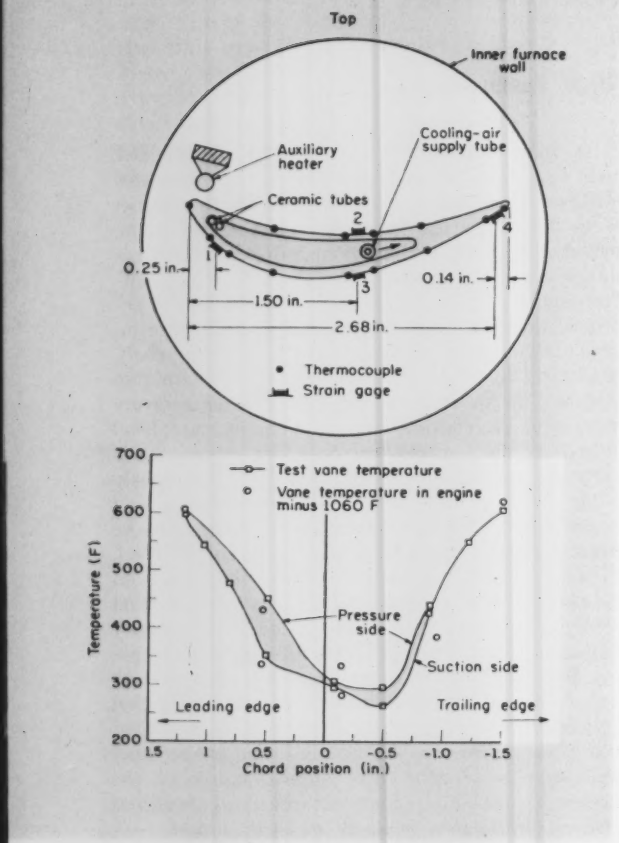


Fig. 89—Experimental setup and test results for simulating shape of temperature distribution in nozzle vane at a level reduced by 1060 F at every point.

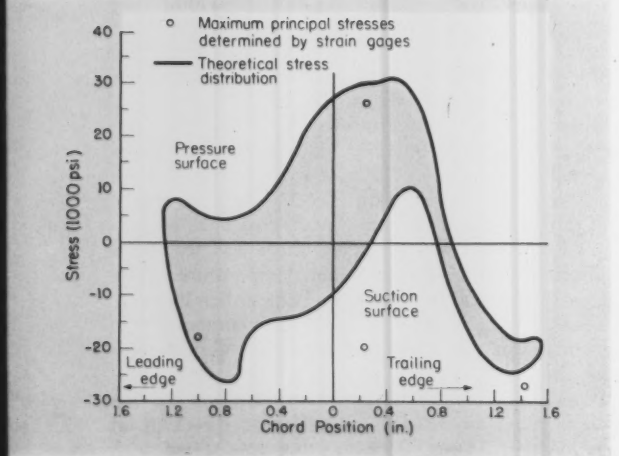


Fig. 90—Thermal stresses in gas-turbine stator vane.

were made for purposes of comparison. The vane was considered to be a beam and Equation 39 was applied.[7] Results of the comparison are shown in Fig. 90. Deviations were caused by the assumptions involved in the computations. A high degree of biaxiality was found experimentally, in contrast to the uniaxial system assumed in the computations. Also, the principal directions were not axial and transverse, being off as much as 24½ deg. Buckling which was not predicted by the simple theory was also indicated. This emphasized the need for an experimental approach to supplement design calculations.

Plastic Range

Most applications of strain gages involve measurements in the elastic range. Gage elements themselves are usually linearly sensitive to strain well into the plastic range. But, the bond between gage and test surface—particularly if the cement is ceramic—fails at high strain, sometimes in the elastic range. Thus, although there is no reason for avoiding thermal stress measurements at elevated temperatures in the plastic range, the techniques have not as yet been investigated. Also, indirect approaches using measurements in the elastic range to provide information on the plastic range are possible. Both of these approaches will be considered here.

Indirect Method: Assume a body of complex shape and/or temperature distribution in which plastic flow is suspected under the most severe conditions of operation. If mechanical forces are absent and only thermal effects exist, and if the region of plastic flow is small, a first approximation would be that the strain distribution is independent of whether the body remains elastic or becomes plastic. This approach has been analytically demonstrated in connection with the development of methods for computing stress and strain distribution in the plastic range.[19]

The principle of strain invariance is a rough approximation, and is not valid when the strains are large and when a large volume of the body flows plastically. But, for plastic strains in the yield-point region, and for highly localized plastic flow under high temperature gradients, the assumption is reasonably valid. The objective then is the determination of the nominal elastic-strain distribution. Once the strains have been determined, that portion of the strain which is elastic and that which is plastic, and hence, the strain and stress distribution, can be established from the stress-strain curve.

The problem is now simplified: Determining the strain distribution present if the material remains elastic under the operating temperature distribution. Thus, measurements can be made at a lower average temperature level. The highest temperature at a measuring station in the body is chosen as that which can experimentally be accommodated by the gage—for example, 800 F for Karma gages.

All other points in the body would be subjected to lower temperatures such that the gradients are every-

where a constant fraction of the actual gradients. For example, a disc with a linear temperature distribution between center and rim from 400 to 1200 F could be replaced by a linear temperature distribution from 600 to 800 F. Hence, the gradients are only 1/4 those of the original disc, and thus, the strains induced are only 1/4 those of the original disc. Assuming that the lower stresses do not induce plastic flow, the experimental values, multiplied by 4, would yield the nominal elastic strains under the actual temperature conditions. These nominal strains are then separated into elastic and plastic portions.

This method assumes no effect on the strain distribution due to redistribution of elastic moduli as the temperatures are changed. When the modulus is constant throughout the body, strain distribution is independent of the modulus. But if the modulus varies, the strains are dependent on the modulus. Hence, some error can be expected because of the modulus effects. In addition, errors are introduced by the approximate nature of the strain invariance principle.

Alternate Method: The assumption of strain invariance can be avoided by combining the nominal elastic strains with residual strain measurements. In this approach, elastic strains are determined as before by extrapolation from strains measured at a lower, but proportional, distribution of temperature differences. The body is then subjected to the actual temperature distribution during which plastic flow occurs. However, no measurements are taken until the body is returned to room temperature. Measurement of the residual stresses by one of a number of available techniques provides the amount of plastic flow required for combination with the elastic computations.

The method, and its limitations are best explained through an example making use of a circular plate with a radial temperature distribution. Elastic stress and strain distribution is governed by the equilibrium, compatibility, and stress-strain equations:[6]

$$\frac{d\sigma_{r,el}}{dr} + \frac{\sigma_{r,el} - \sigma_{t,el}}{r} = 0$$

$$\frac{d\varepsilon_{t,el}}{dr} + \frac{\varepsilon_{t,el} - \varepsilon_{r,el}}{r} = 0$$

$$\varepsilon_{r,el} = \frac{\sigma_{r,el} - \mu\sigma_{t,el}}{E_h} + \alpha T$$

$$\varepsilon_{t,el} = \frac{\sigma_{t,el} - \mu\sigma_{r,el}}{E_h} + \alpha T \qquad (113)$$

If plastic stresses and strains were calculated, they would satisfy

$$\frac{d\sigma_{r,pl}}{dr} + \frac{\sigma_{r,pl} - \sigma_{t,pl}}{r} = 0$$

$$\frac{d\varepsilon_{t,pl}}{dr} + \frac{\varepsilon_{t,pl} - \varepsilon_{r,pl}}{r} = 0$$

$$\varepsilon_{r,pl} = \frac{\sigma_{r,pl} - \mu\sigma_{t,pl}}{E_h} + \varepsilon_{r,p} + \alpha T$$

$$\varepsilon_{r,pl} = \frac{\sigma_{t,pl} - \mu\sigma_{r,pl}}{E_h} + \varepsilon_{r,p} + \alpha T \qquad (114)$$

For this problem, Equations 113 and 114 are solved, subject to the boundary conditions $\sigma_{r,el} = 0$ or $\sigma_{r,pl} = 0$ at r = disc radius, and $\sigma_{r,el} = \sigma_{t,el}$ or $\sigma_{r,pl} = \sigma_{t,pl}$ at $r = 0$. By subtracting corresponding equations, the differences between the equilibrium equations and between the compatibility equations become

$$\frac{d(\sigma_{r,pl} - \sigma_{r,el})}{dr} + \frac{(\sigma_{r,pl} - \sigma_{r,el}) - (\sigma_{t,pl} - \sigma_{r,el})}{r} = 0$$

$$\frac{d(\varepsilon_{t,pl} - \varepsilon_{t,el})}{dr\,dr} + \frac{(\varepsilon_{t,pl} - \varepsilon_{t,el}) - (\varepsilon_{r,pl} - \varepsilon_{r,el})}{r} = 0 \qquad (115)$$

From the stress-strain relations,

$$(\varepsilon_{r,pl} - \varepsilon_{r,el}) = \frac{(\sigma_{r,pl} - \sigma_{r,el}) - \mu(\sigma_{t,pl} - \sigma_{t,el})}{r} + \varepsilon_{r,p} \qquad (116)$$

A corresponding equation can be obtained for $(\varepsilon_{t,pl} - \varepsilon_{t,el})$.

Equations for determining the residual stresses are considered after the disc has been returned to room temperature. If it is assumed that no reversed plastic flow occurs while the disc is cooling off, then the strains $\varepsilon_{r,p}$ and $\varepsilon_{t,p}$ induced by plastic flow at a specific time are regarded as permanently induced strains, and the total strain in either of the two principal directions is the sum of the permanent strain from the prior plastic flow, plus any elastic strains induced by the residual stresses. Thus,

$$\varepsilon_{r,res} = \frac{\sigma_{r,res} - \mu\sigma_{t,res}}{E_c} + \varepsilon_{r,p} \qquad (117)$$

where $\varepsilon_{r,p}$ has exactly the same magnitude as in Equation 116.

A similar equation can be written for $\varepsilon_{t,res}$, and for the equilibrium and compatibility equations. For the equilibrium equation,

$$\frac{d\sigma_{r,res}}{dr} + \frac{\sigma_{r,res} - \sigma_{t,res}}{r} = 0 \qquad (118)$$

Equations 116 and 117 show them to be identical, if the differences between the plastic and elastic stresses are replaced by the residual stresses. Furthermore, the boundary conditions are the same since $\sigma_{r,res} = \sigma_{t,res}$ at $r = 0$ and $\sigma_{r,res} = 0$ at r = disc radius. These are the same conditions that exist when the residual stresses are replaced by the difference between plastic and elastic stresses. If the equations and the boundary conditions are the same, the solutions must be identical. Hence, the plastic stress distribution can be determined as the sum of the elastic and measured residual stresses.

Two conditions that limit the applicability of this approach for measuring plastic stress distribution exist: 1. The elastic modulus must be constant over the entire temperature range considered, that is, $E_h = E_c$. In general, this is not true. However, small differences in the elastic modulus will not have a large

effect on strain distribution. 2. No reverse plastic flow must have occurred upon cooling; otherwise, $\varepsilon_{r,p}$ and $\varepsilon_{t,p}$ will not be the same in the two sets of equations.

Some indication of whether reverse plastic flow has occurred is given by the residual stress measurements themselves. If they are near the yield point over a considerable distance, it can be assumed that reverse plastic flow has occurred. Thus, the method should not be applied literally, although it may be of use qualitatively.

Illustrations: As an example of the foregoing approach, use is made of data obtained to check the validity of deformation and incremental theories in computing the plastic flow in a flat circular plate subjected to successive temperature distributions.[20] Actually, the plastic flow occurred during both temperature application and temperature removal. Hence, the method described would not normally be valid. However, it is a useful example to indicate procedure, to point out precautions, and to indicate how both of the methods discussed can be used to supplement each other.

For cases involving plastic flow, this method would not be used when the theoretical analysis is simple. When theoretical analysis is not readily accomplished because of problem complexity, this approach is of direct application. Hence, it is assumed that both elastic and plastic analyses would be difficult for the problem, and that the best way to determine elastic strain distribution is by measurement. Actually, because this problem is a simple one, hypothetical measurements in the elastic range can be replaced by computed values.

Strain gages are mounted in the disc prior to subjecting it to heat, and a temperature distribution is applied, such that any point in the disc is above a reference temperature by a constant fractional amount of the actual operating temperature distribution. The complete history of temperature distribution, to the reduced scale, can then be traversed, and the thermal stresses measured by the strain gages. The temperature distribution at which the measured elastic thermal stress reaches a maximum becomes the first point of focus. Elastic strains, measured at this condition, are divided by the temperature reduction ratio to obtain the nominal elastic strains for the true temperature distribution.

Once the nominal elastic strains are determined, the first of the two alternative procedures is applied. Assume that the plastic strains are equal to the nominal elastic strains. Since the latter strains are known, they can be apportioned into elastic and plastic components. Separating known total biaxial strains into their elastic and plastic components is accomplished by the concept of equivalent total strain.[11]

For this example, a temperature distribution 72 seconds after heat application was chosen for the plastic analysis. Fig. 91 shows the actual temperature distribution and the temperature distribution experimentally simulated for elastic measurements. For

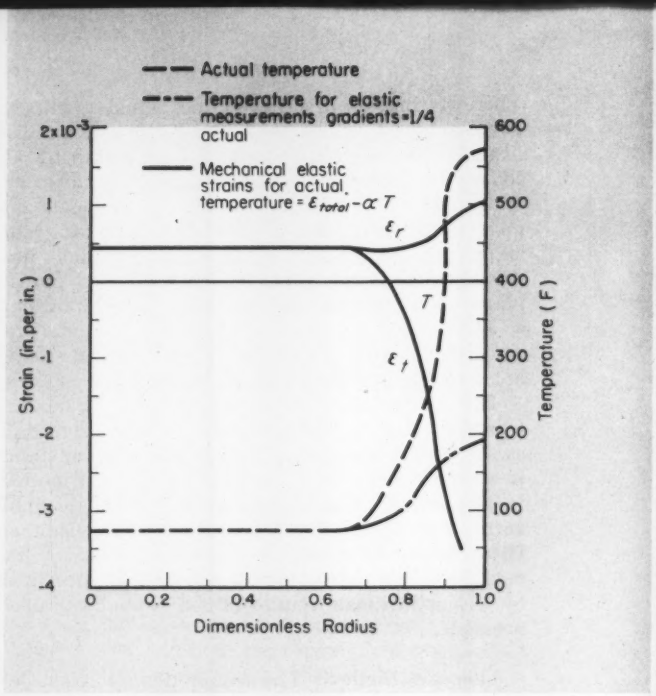


Fig. 91—Temperatures and mechanical strains in disc using strain-invariance method.

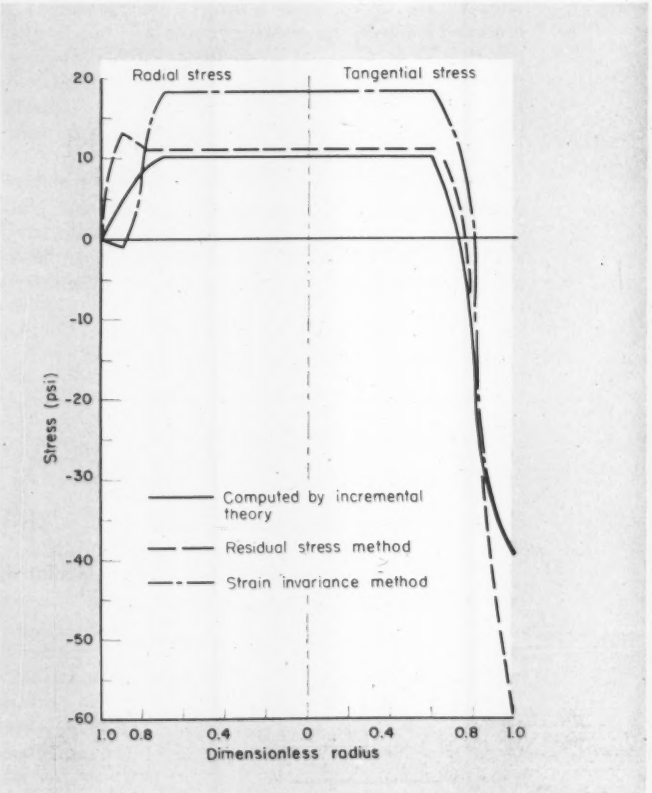


Fig. 92—Comparison of results determined by several methods of plastic stresses in a circular plate under symmetrical radial temperature distribution.

this example, the computations are taken as measurements. Extrapolating the measurements to the true temperature distribution, and applying the strain invariance principle, results in the plastic stress distribution, Fig. 92. Comparison indicates that the results are good in the vicinity of the rim, where the plastic flow occurs. In the center of the disc the discrepancy is appreciable. The reason for this is that strain invariance seems to apply where plastic flow occurs. However, the plastic flow in the rim region reduces the induced stresses in the elastic region. So, in the center region, the stresses computed on the basis of strain invariance are too high. Thus, although the strain system chosen satisfies the compatibility equation, the implied stresses do not satisfy the equilibrium equations when the disc is partially elastic and partially plastic. The degree of error depends on the volume involved in the plastic flow. When this volume is small, the effect in the elastic region is small. In this case, since the volume is appreciable, considerable error is involved.

For calculations based on the measured residual stresses and the "measured" elastic strains, the agreement with the theoretical values is good in the elastic region toward the central portion of the disc, but poor in the rim region where plastic flow occurs. The discrepancy is not due to the plastic flow at the high temperature, since this is precisely what causes the residual stresses. In principle the plastic stresses are the sum of elastic and residual stresses.

It is the reverse plastic flow occurring upon cooling, but not accounted for in the analysis, that causes the difficulty. The elastically computed residual stresses are higher than the yield point in the rim region, causing reverse plastic flow. The influence of this plastic flow on the stresses in the central region is small.

Thus, a combination of the two methods described —with emphasis on the strain invariance method in the plastic flow region and on the residual stress method in the elastic region—can yield a reasonable engineering estimate of the plastic stress distribution in the first cycle of operation.

The next article in this series will discuss photoelasticity and techniques for applying this method to thermal-stress measurement.

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This article is the fifteenth in a series by S. S. Manson on thermal stresses in design. Previous articles and issues of MACHINE DESIGN in which they appeared are:

1. "Appraisal of Brittle Materials" ..... June 12, 1958
2. "Quantitative Techniques for Brittle Materials" .. June 26, 1958
3. "Basic Concepts of Fatigue in Ductile Materials" ..... August 7, 1958
4. "Causes of Fatigue in Ductile Materials" .... August 21, 1958
5. "Interpretation of Fatigue Data for Ductile Materials" ..... September 4, 1958
6. "Elastic Stress Analysis" ..... January 22, 1959
7. "Exact and Approximate Solutions" ..... February 5, 1959
8. "Elastic Stresses by Energy Methods" ..... February 19, 1959
9. "Elastic Stress Solutions" ..... March 5, 1959
10. "Elastic Stresses by Minimizing Residuals" March 19, 1959
11. "Stresses Under Plastic Flow and Creep" ..... July 9, 1959
12. "Plastic Stresses and Strains by Successive Approximations" ..... July 23, 1959
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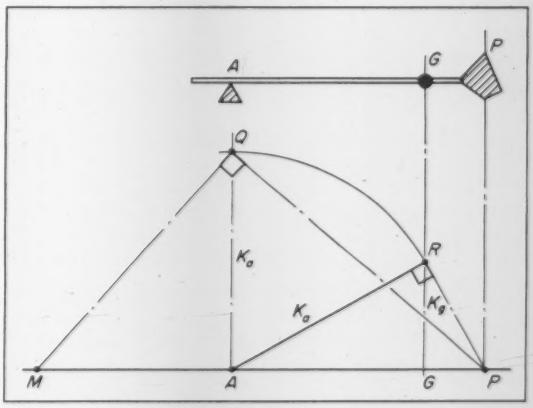
Tips and Techniques

Locating Center of Percussion

The relationship between the suspension point, the center of gravity and the center of percussion, can be laid out graphically. The quantities required to lay out the figure are the radius of gyration with respect to the center of gravity, K_g, and the radius of gyration with respect to the suspension point, K_a. Center of gravity is shown as G.

To find A, the suspension point for no reaction when a force is applied along PP, erect a perpendicular at G equal to K_g. From R draw a perpendicular to RP intersecting PG at A.

To find P when A is known, draw AM equal to AG. Erect K_a perpendicular to AM at A. Draw a perpendicular to MQ intersecting AM at P.—H. A. BORCHARDT, *University of New South Wales, Sydney, Australia.*



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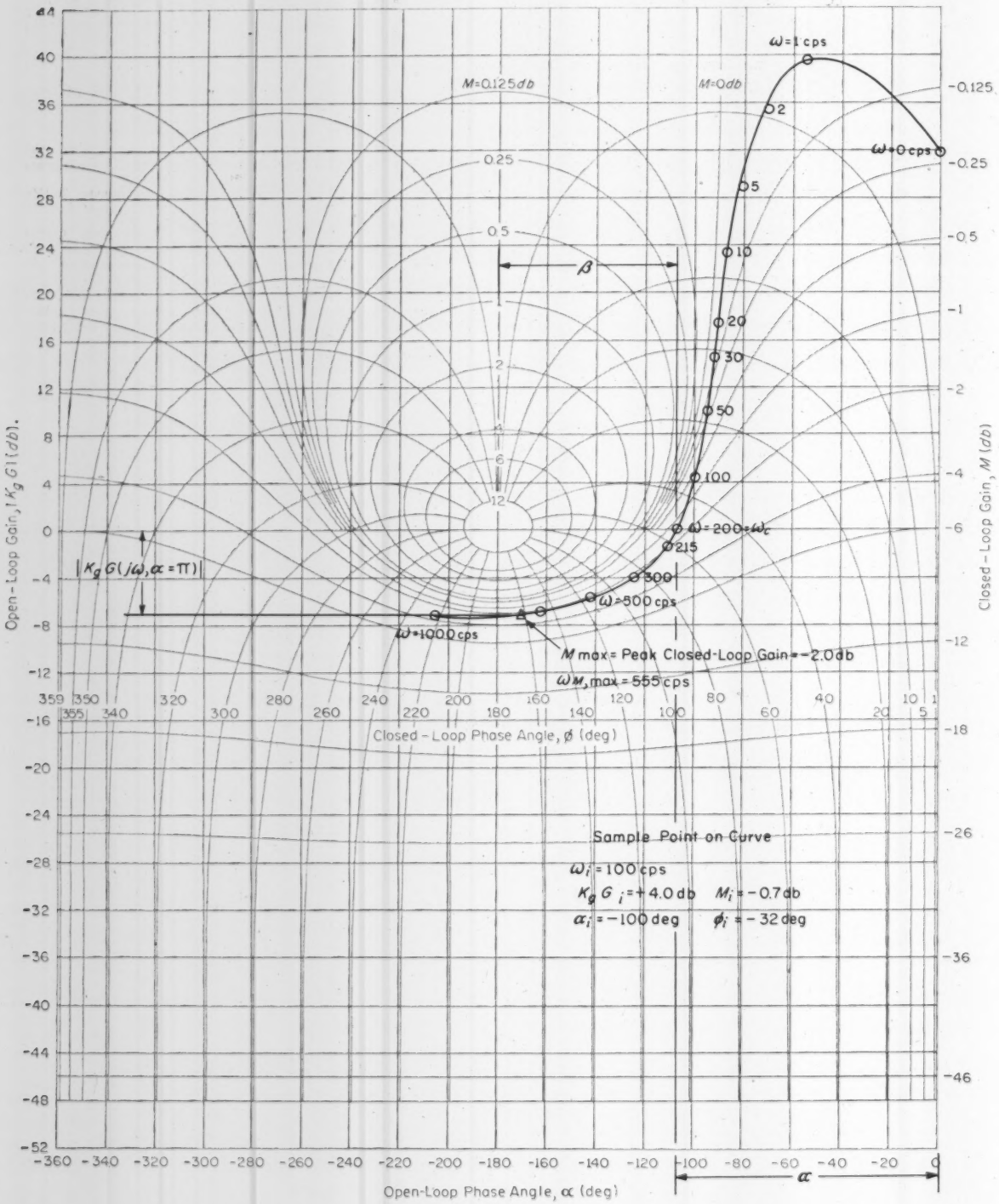

Fig. 1—Plot of direct feedback system.

Modified Nichols Chart— a graphical aid for

Synthesizing Servo Systems

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PERFORMANCE of automatic feedback systems can be evaluated by two major criteria: Stability and response. Stability is generally indicated by the relative magnitude and direction (phase) of the input and output. Response is characterized by the readiness of the output to follow the input with the desired sensitivity and accuracy.

Many graphical techniques have been used to determine or illustrate these two important system characteristics.[1,2,3] This article extends the use of one —the Nichols chart—for synthesizing any single-loop feedback system. The chart, a plot of log modulus (gain) versus phase angle, is called here simply *modulus-angle* chart.

Other Graphical Techniques for Determining System Characteristics

1. **Nyquists plot of the open-loop transfer function.[1]**
2. **Bode diagrams of open-loop function versus frequency and phase loci versus frequency.[1]**
3. **Root-locus method, developed by W. R. Evans, in which the open-loop transfer function is used to find roots of the closed-loop transfer function.[2]**
4. **Modulus-angle chart proposed by N. B. Nichols at the M.I.T. Radiation Laboratory[3]—method extended in this article.**

Basic Characteristics

The modulus-angle chart has two sets of co-ordinates. The rectangular co-ordinates represent a graphical system with the open-loop transfer-function gain as ordinate and the corresponding phase angle as abscissa. Both of these quantities vary with the frequency, ω. Therefore, a curve, Fig. 1, can be plotted for the open-loop transfer function, $K_g G(S)$ or $K_g G(j\omega)$, by varying ω.

The second set of co-ordinates on the chart is curvilinear. This set of curved lines represents the mathematical relation between the open-loop transfer function, $K_g G(S)$, and the corresponding closed-loop transfer function of a *unit* or *direct* feedback system, Fig. 2.

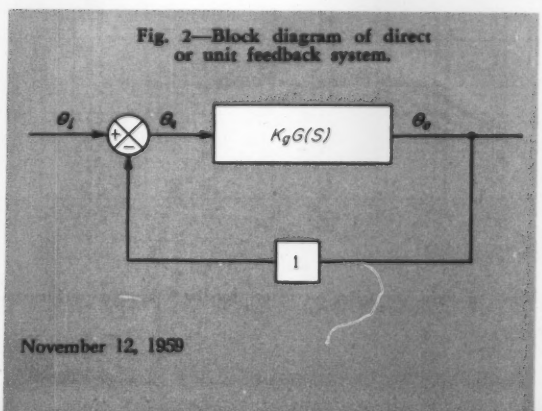

Fig. 2—Block diagram of direct or unit feedback system.

With this double co-ordinate arrangement, either the closed or open-loop characteristics can be plotted, and one can be converted directly to the other. The only limitation on the use of this chart is that direct conversion can be performed only for *direct* feedback systems.

The modulus-angle chart depicts a great deal of vital information for the stability and response of a feedback system:

Complete description of both open-loop and closed-loop characteristics for a *unit* feedback system are given on one plot.

Full list of parameters, vital to system stability, response, and other performance characteristics, can be read easily from the chart. The parameters which can be read from the plot, Fig. 1, for a single-loop *unit* feedback system are:

1. Overall phase shift, α, a function of frequency $\alpha(\omega)$, for the open-loop transfer function.

[1]References are tabulated at end of article.

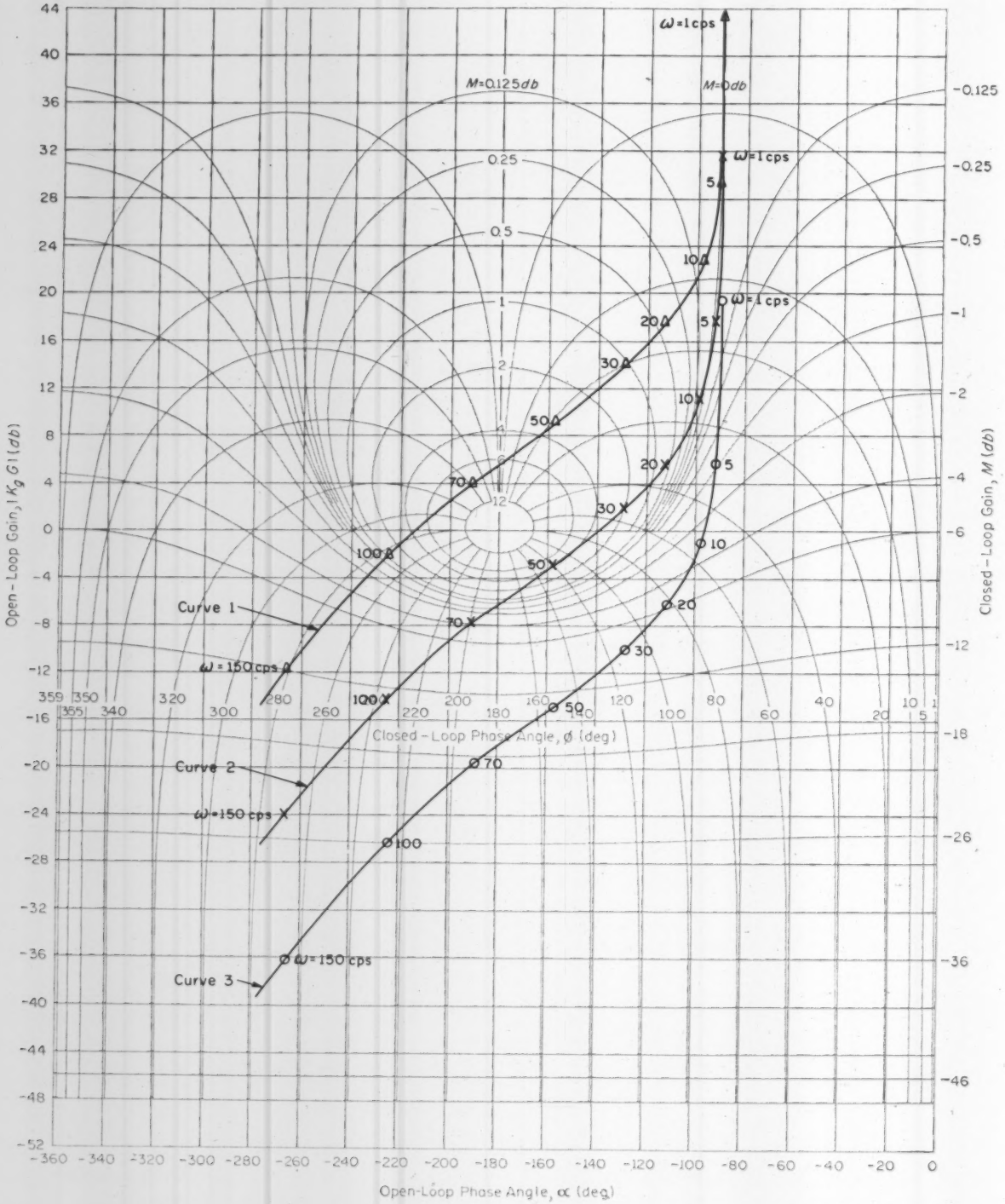

Fig. 3—Effect of gain variation on direct feedback system performance.

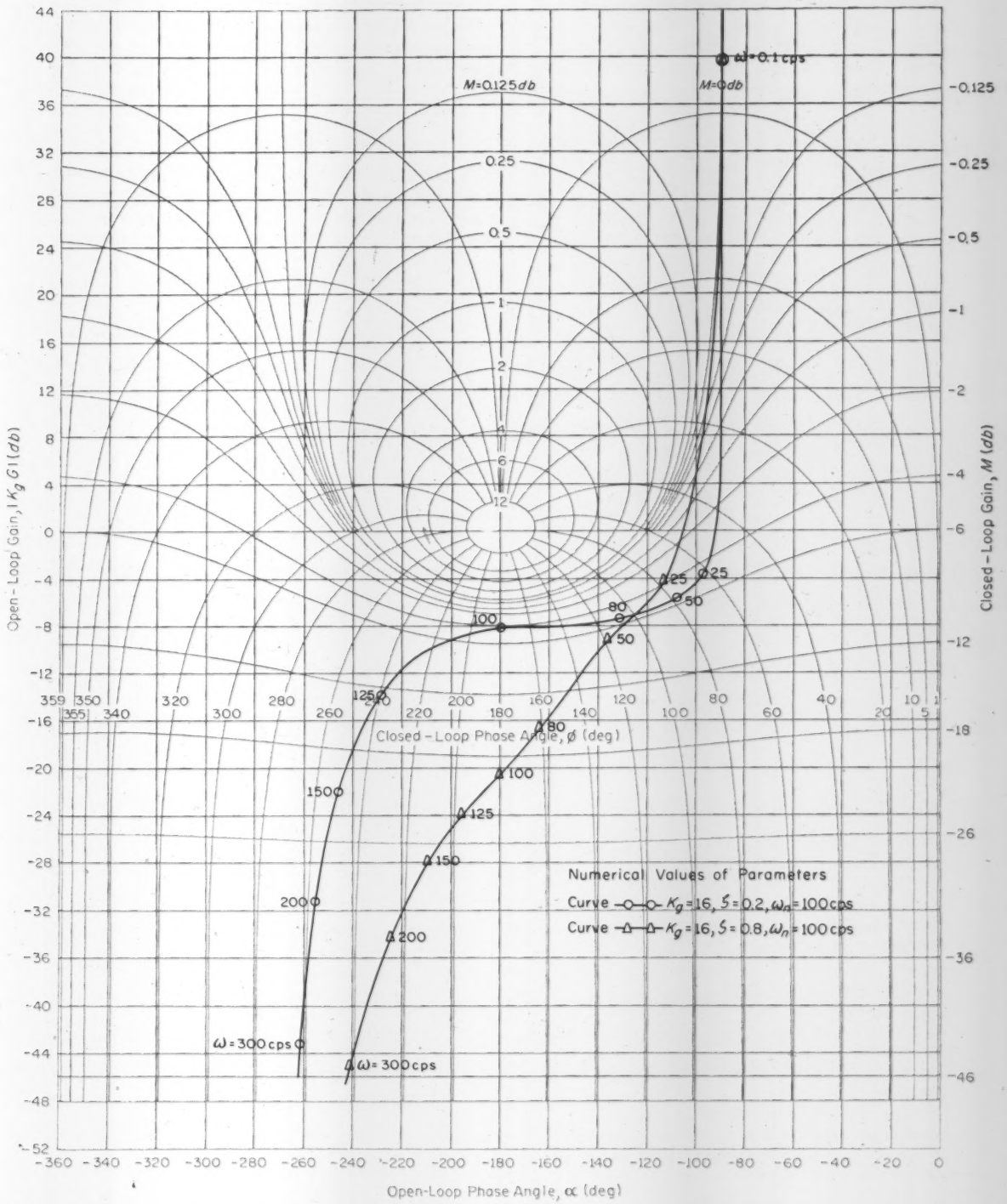

Fig. 4—Open-loop plots of servo transfer function, $K_v G(S) = K_v \omega_n^2 / S (S^2 + 2\zeta\omega_n S + \omega_n^2)$

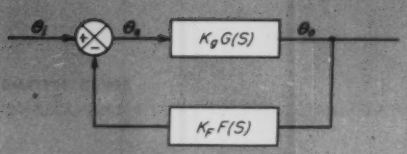

Fig. 5—Block diagram of closed-loop feedback system.

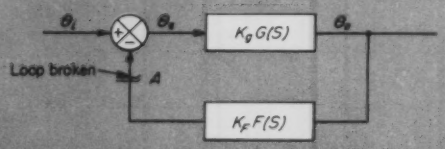

Fig. 6—Closed-loop system broken to give open-loop transfer function.

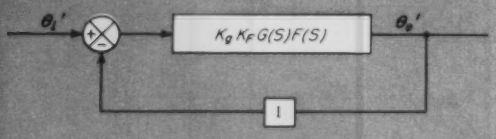

Fig. 7—Closed-loop system reduced to a fictitious one with unit feedback.

2. Phase margin, β, the supplemental angle of α.
3. Gain margin, the quantity in decibels measured along the ordinate of the rectangular co-ordinate system, $|K_g G(j\omega, \alpha = \pi)|$.
4. Peak closed-loop gain, M_{max}.
5. Frequency at M_{max}, $\omega_{M,max}$.
6. Cross-over frequency ω_c, the frequency at 0 decibel open-loop gain.
7. Closed-loop gain M_i and closed-loop phase angle ϕ_i at any frequency ω_i. These quantities are read directly from the chart if the modulus angle plot has been established through the open-loop transfer function.
8. Open-loop gain $K_g G_i$ and phase α_i. The curve, obtained when these quantities are calculated at various frequencies, embodies the dynamic properties of the *direct* feedback system, Fig. 2.

Effects of varying forward path gain are indicated. Any increase or decrease in K_g does not change the shape of the curve. Adjustment of the K_g value merely moves the whole curve up or down the chart.

Effects of damping adjustment on the system are depicted. Any damping adjustment, in general, involves moving a portion of the curve in a certain frequency range horizontally or parallel to the abscissa of the rectangular co-ordinates.

Hence, a servo system can be synthesized by using the characteristics of the Nichols chart. For example, the effects of varying forward path gain are depicted in three plots of an actual servo system, Fig. 3. All three curves differ in forward path gain only. Curve 1 has the highest value of K_g and crosses the centerline, $\alpha = 180$ deg, above the origin of the rectangular co-ordinate system. In other words, the open-loop transfer function of the servo system possesses a positive gain, $K_g G(S) > 0$, at $\alpha = 180$ deg. Therefore, the gain is excessive and the system is oscillatory.

If curve 1 is moved downward 12 db, or gain K_g is reduced to one-fourth of the gain for curve 1, curve 2 gives the gain characteristic. Curve 2 passes through the centerline at $K_g G(S) = -6$ db. Therefore, the synthesized system will have satisfactory gain adjustment.

If gain K_g is reduced to one-sixteenth of the gain for curve 1, curve 3 results. Curve 3 has a gain margin of 18 db. Since this gain is too low, the system will be sluggish.

For a second example, consider effect of varying damping coefficient of a third order system which has the open-loop transfer function in the form of:

$$\frac{\theta_o(S)}{\theta_e(S)} = K_g G(S) = \frac{K_g \omega_n^2}{S(S^2 + 2\zeta\omega_n S + \omega_n^2)}$$

Changes in the damping coefficient from 0.2 to 0.8 decrease the phase shift of the curve for higher frequencies, Fig. 4.

Extended Chart Use

The modulus-angle chart can be used in designing servo systems only if the feedback has a ratio of unity. The use of this chart can also be extended for application to any feedback system by combina-

Nomenclature

$F(S)$	= Feedback-path transfer function
$G(S)$	= Forward-path transfer function
K_F	= Feedback-path gain, db
K_g	= Forward-path gain, db
M	= Closed-loop gain, db
S	= Laplace operator
α	= Phase angle, open-loop transfer function, deg
ζ	= Damping ratio
θ_e	= Error or loop-actuation signal, deg
θ_i	= Feedback-system input, deg
θ_o	= Feedback-system output, deg
τ	= Time constant, sec
ϕ	= Closed-loop phase angle, deg
ω	= System operating frequency, cps
ω_n	= Damped natural frequency, cps

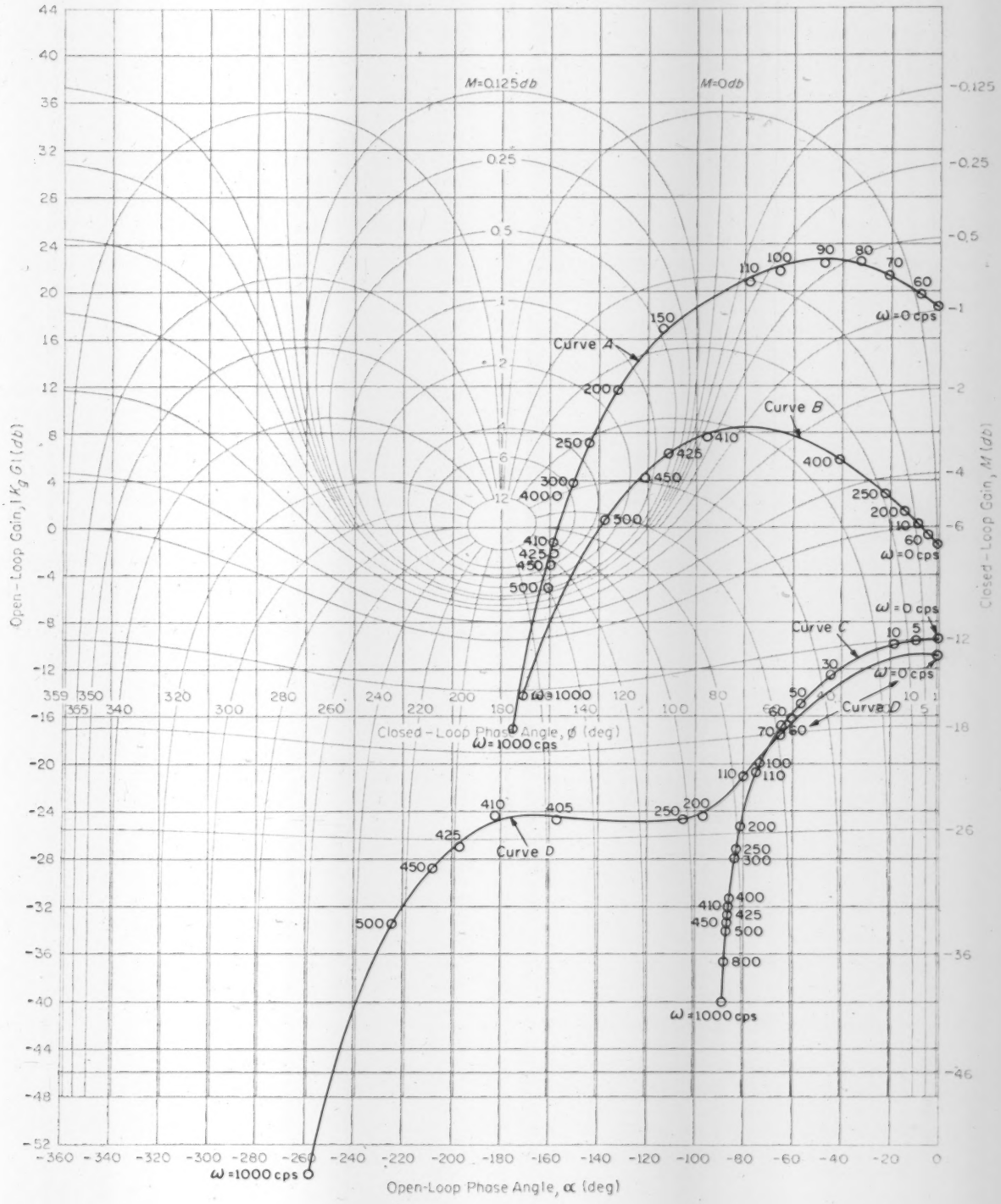

Fig. 8—Graphical determination of dynamic response for single-loop system of Fig. 9.

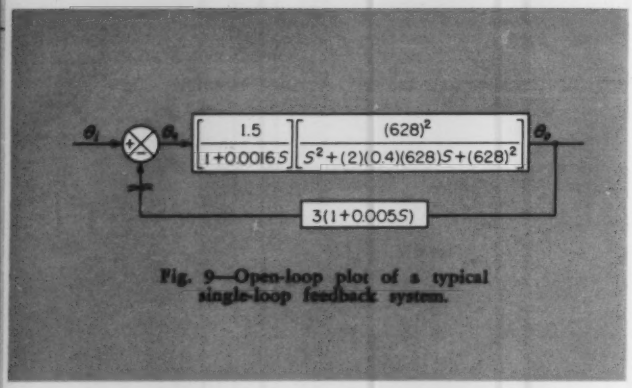

Fig. 9—Open-loop plot of a typical single-loop feedback system.

tion with other graphical approaches.[4] The scheme illustrated here is different. In this extension, only the modulus-angle chart is used, and the clear relation between the closed-loop and open-loop characteristics of the feedback system is retained.

If the typical feedback system is represented by the block diagram in Fig. 5, the closed-loop transfer function is

$$\frac{\theta_o(S)}{\theta_i(S)} = \frac{K_g G(S)}{1 + K_g K_F G(S) F(S)} \qquad (1)$$

However, if the feedback loop is broken at point *A*, Fig. 6, the open-loop transfer function, $K_g K_F G(S) F(S)$, can be plotted on the modulus-angle chart. The plotted curve can be read by the curvilineal co-ordinates of the chart to obtain the closed-loop frequency response properties corresponding to a fictitious system, Fig. 7. The closed-loop transfer function of the fictitious system is

$$\frac{\theta_o'(S)}{\theta_i'(S)} = \frac{K_g K_F G(S) F(S)}{1 + K_g K_F G(S) F(S)} \qquad (2)$$

If Equations 1 and 2 are compared,

$$\frac{\theta_o(S)}{\theta_i(S)} = \frac{1}{K_F F(S)} \left[\frac{\theta_o'(S)}{\theta_i'(S)} \right] \qquad (3)$$

From Equations 1, 2, and 3, the graphical procedure for synthesis of a single-loop feedback system can be established. The dynamic characteristics of $\theta_o(S)/\theta_i(S)$ can be determined by plotting several curves on the Nichols chart after K_g, K_F, and $F(S)$ are either arbitrarily chosen or preassigned in preliminary design.

Graphical Procedure

1. Plot the open-loop transfer function, $K_g K_F G(S) F(S)$, of the feedback system on the modulus-angle chart.

2. Read the curvilinear co-ordinates of the closed-loop characteristics for $\theta_o'(S)/\theta_i'(S)$ from the chart. Transfer the amplitude ratio and phase angle values for various frequencies to the rectangular co-ordinates. Hence, a new curve of amplitude ratio in decibels vs phase-angle for various frequencies is obtained on the rectangular co-ordinates. This new curve on rectangular co-ordinates is the closed-loop characteristic of the system, $\theta_o'(j\omega)/\theta_i'(j\omega)$, with the gains K_g and K_F set at certain arbitrary values.

3. Plot the function $1/K_f F(j\omega)$ on the rectangular co-ordinates. Feedback gain of the actual feedback system is arbitrarily assigned for the plot, and can be assigned any new values in the process of system synthesis. Change of K_F does not affect the shape of the plotted curve, but merely causes the plot to shift vertically on the rectangular co-ordinates.

4. With the transfer function plots of $1/K_F F(j\omega)$ and $\theta_o'(j\omega)/\theta_i'(j\omega)$ in rectangular co-ordinates, the closed-loop characteristics of the actual feedback system, $\theta_o(j\omega)/\theta_i(j\omega)$, with arbitrary gain settings of K_g and K_F, can be obtained by cascading the transfer functions, Equation 3. Hence, for any $\omega = \omega_i$, the amplitude ratios and phase angles of the two transfer functions can be algebraically added together. The algebraic sum of these quantities, plotted on the rectangular co-ordinates of the same chart, represent the closed-loop dynamics of the actual feedback system at various frequencies.

5. From the curve obtained in step 4, the general information of the feedback system, $\theta_o(j\omega)/\theta_i(j\omega)$, such as magnification and attenuation of output amplitude, phase difference between input and output, and the transitional behavior of the closed-loop system can be studied over a certain frequency range.

6. The forward path gain and the feedback path gain can be adjusted by moving the $1/K_F F(S)$ and $\theta_o'(S)/\theta_i'(S)$ curves vertically up and down the rectangular co-ordinate plane. The resultant curve for $\theta_o(S)/\theta_i(S)$, with the newly adjusted K_g and K_F, can be plotted to synthesize the desired qualities of the feedback system.

EXAMPLE: Assume the forward-path transfer function,

$$K_g G(S) = K_g \frac{1}{1 + \tau_A S} \left[\frac{\omega_n^2}{S^2 + 2\zeta\omega_n S + \omega_n^2} \right]$$

where $\omega_n = 628$ rad per sec, $\zeta = 0.4$, $\tau_A = 0.0016$ sec, and $K_g = 1.5$. Assume the feedback path transfer function,

$$K_F F(S) = K_F(1 + \tau_B S)$$

where $K_F = 3$ and $1 + \tau_b S = 1 + 0.005S$.

Curve *A*, Fig. 8, represents the open-loop plot of the feedback system, Fig. 9. Curve *B* is the closed-loop characteristics of the open-loop plot shown by curve *A*. Hence, curve *B* is the curve plotted in rectangular co-ordinates as a result of carrying out step 2 of the *Graphical Procedure*.

Curve *C* is the plot of the function $1/[3(1 + 0.005S)]$ as described in step 3 of *Graphical Procedure*. Curve *D* represents the closed-loop characteristics of the actual feedback system with arbitrary gain settings.

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Simplified procedures for finding

Wall Thickness of Pressure Vessels

ALLAN W. GILMAN
Associate
Patchen, Mingledorff and Williams
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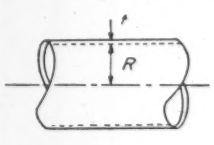
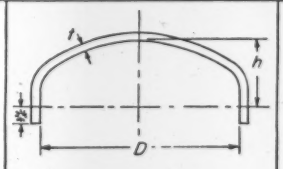
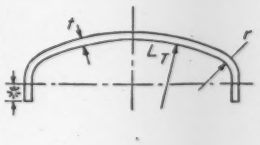
DESIGN of the simpler forms of unfired pressure vessels is not difficult, but it does take time to become familiar with the Code, especially when not designing vessels frequently. To expedite design, nomographs in this article simplify the solution of thickness equations in the *ASME Boiler and Pressure Vessel Code*, Section VIII, Rules for Construction of Unfired Pressure Vessels, 1959 Edition.

Table 1 associates pressure-vessel parts, thickness equations, and conditions under which the equations apply. Solutions for shell thickness and head thickness are obtained with Fig. 1 and 2. In the Keys in Fig. 1, numbers indicate the sequence of steps. Values for K are found in Fig. 1 and carried to Fig. 2.

Example: A tank with an ellipsoidal head will have these features: D = 6 ft, R = 36 in., L = 72 in., P = 250 psi, temperature = 600 F, material is SA7, S = 12,650 psi (UCS-23), E = 80 per cent. From Fig. 1, K = 20.0 for the head and 10.0 for the shell. From Fig. 2, t = 0.9 in. for both shell and head.

Table 1—Minimum Material Thickness

Parts Under Pressure			
			
Cylindrical Shell	Ellipsoidal Head	Torispherical Head	Hemispherical Head
Conditions: All pressures internal--on concave surfaces--and			
$t < \frac{R}{2}$, or $P < 0.385\ SE$	Manufacters' Standard: $h = \frac{D}{4}$	$r = 0.06\ L_T$	$t < 0.356\ L_H$, or $P < 0.665\ SE$
Minimum Thickness, t =			
$\frac{PR}{SE - 0.6P}$	$\frac{PD}{2\ SE - 0.2\ P}$	$\frac{0.885\ PL_T}{SE - 0.1\ P}$	$\frac{PL_H}{2\ SE - 0.2\ P}$
Applicable Paragraph in 1959 Code			
UG-27c	UG-32d	UG-32e	UG-32f

P = design pressure, psi; S = maximum allowable stress, psi.

*Ellipsoidal or torispherical heads intended for butt-weld attachment shall have a minimum skirt length of three times the nominal thickness of head or 1½ in., whichever is smaller. The thickness of skirt shall not be less than for a seamless cylindrical shell of the same diameter. For lap joints, the minimum skirt shall be three times the nominal thickness plus ½ in., but in no case less than 1 in.

†Integral skirt not required by ASME code. If skirt is used, skirt thickness shall be not less than for a seamless cylindrical shell of the same diameter.

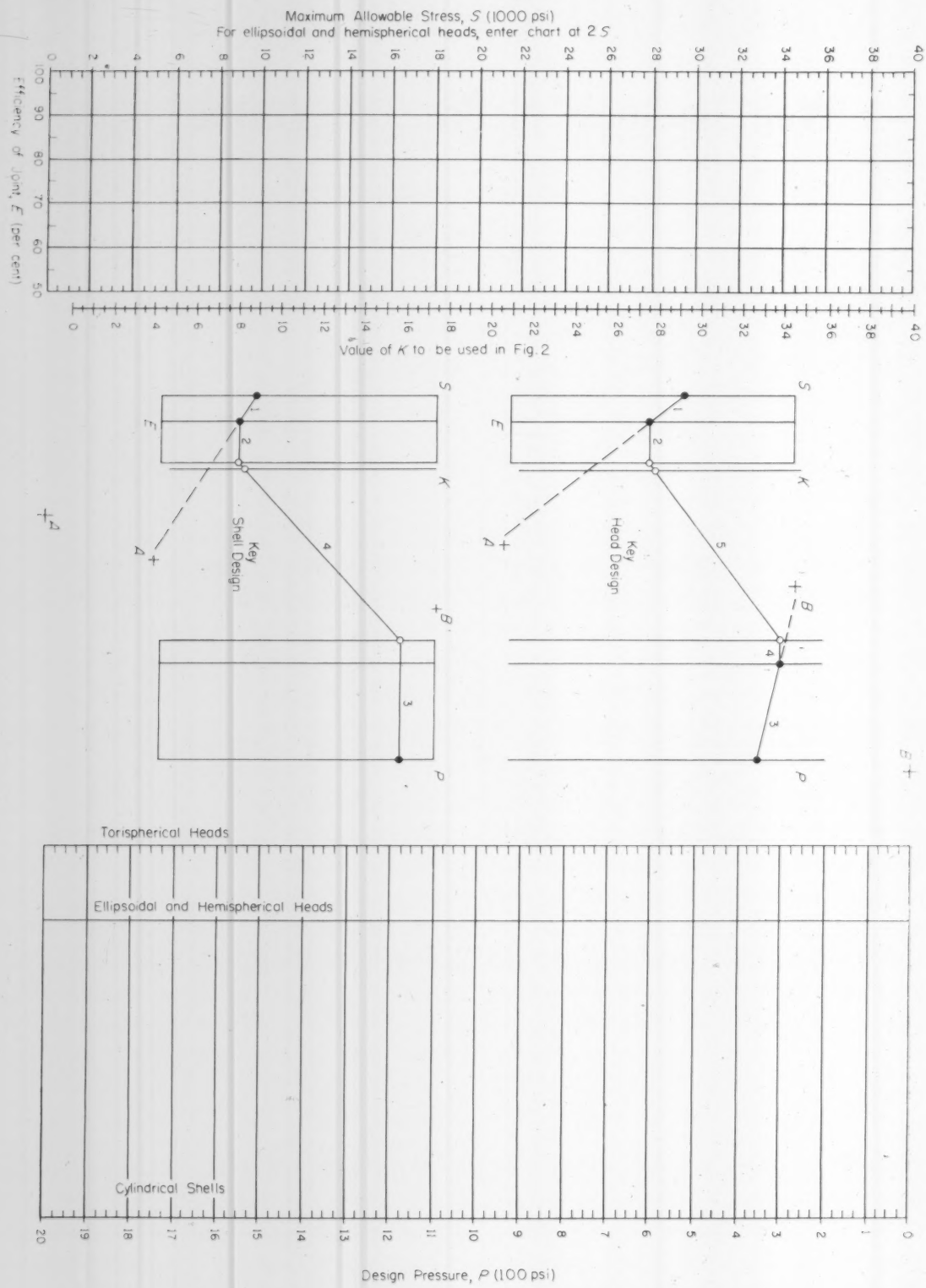


Fig. 1—Values of *K*, which are denominators of thickness equations, determined from variables *E*, *P*, and *S*.

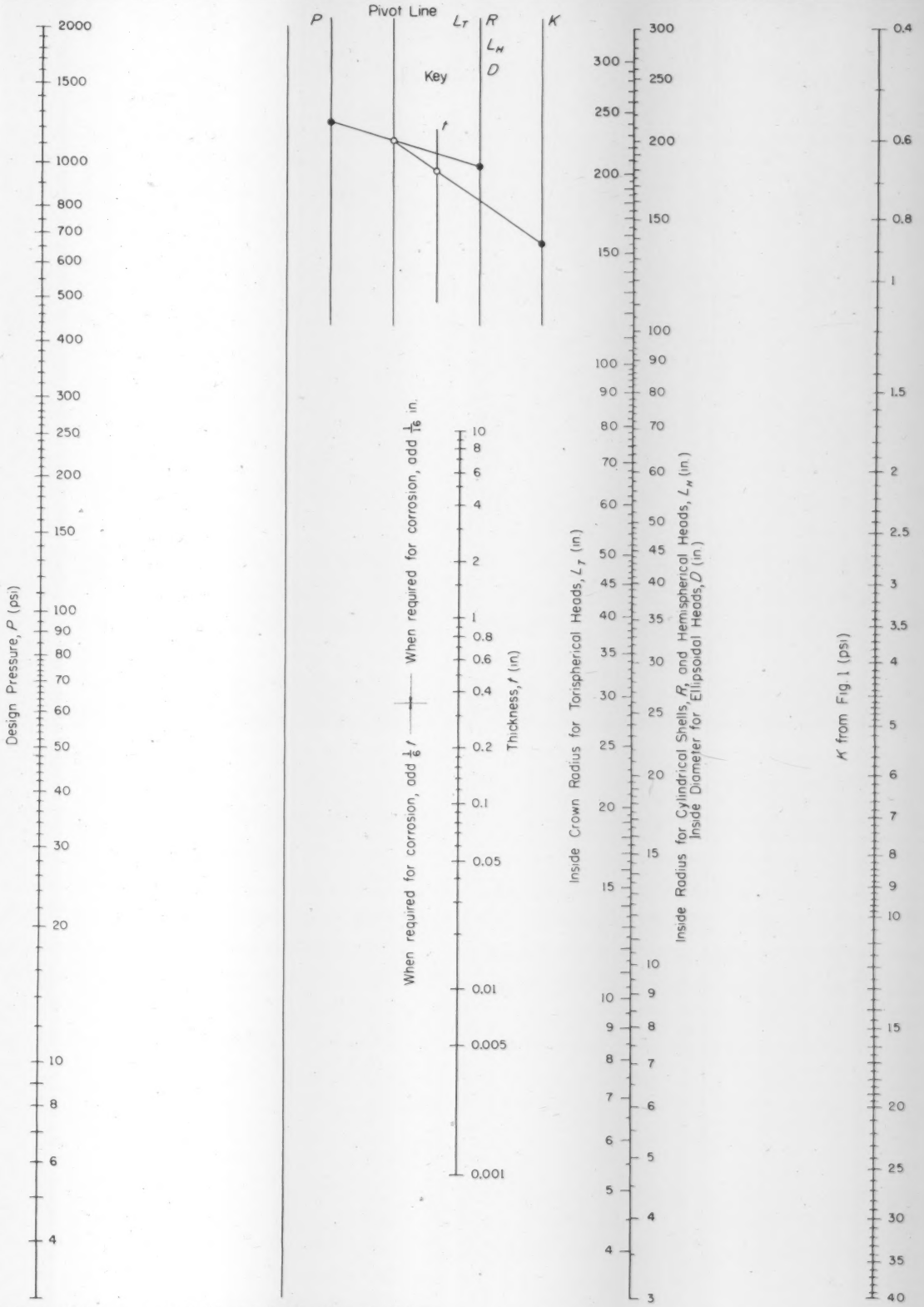
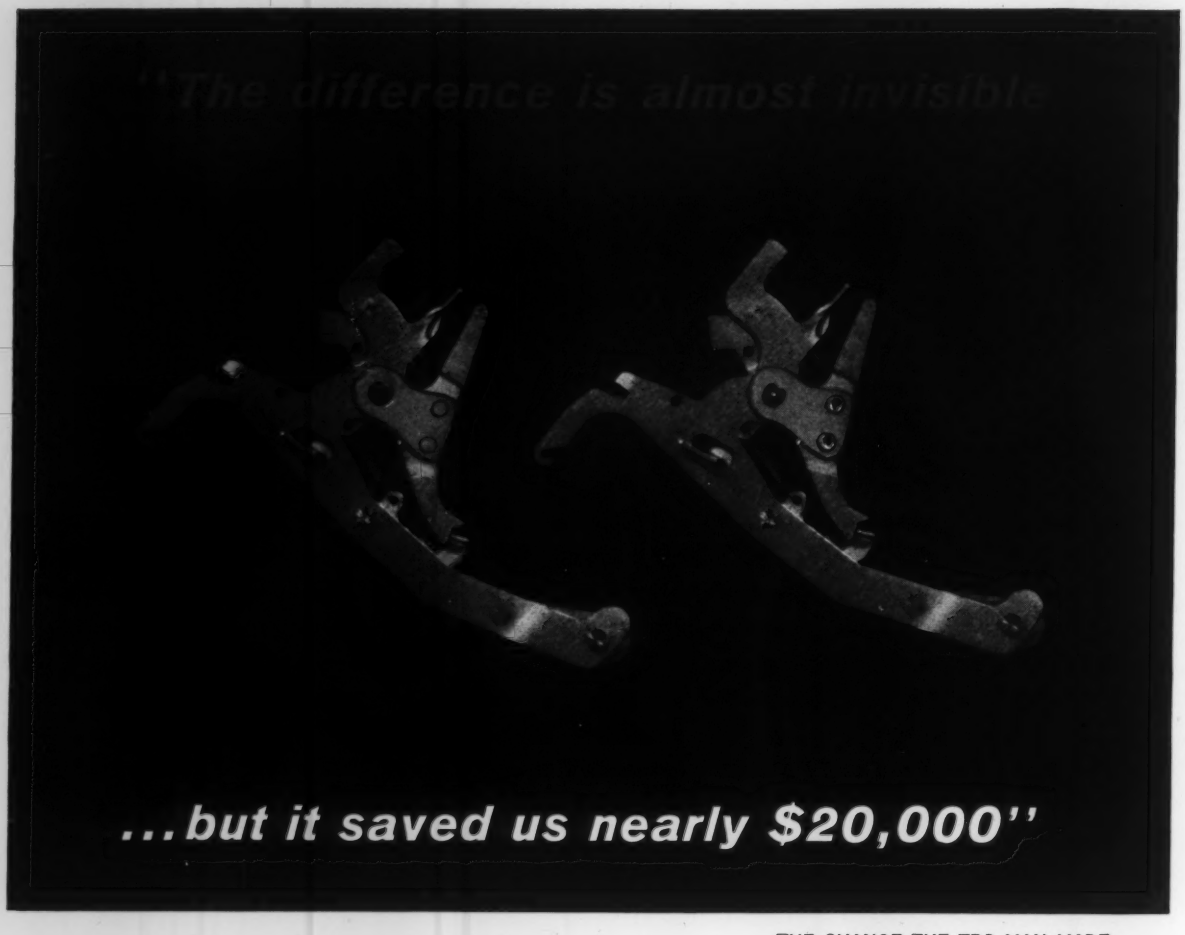


Fig. 2—Thickness *t* of shells and heads, determined from values of *K*, *P*, and certain dimensions of pressure vessels.



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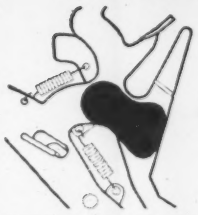

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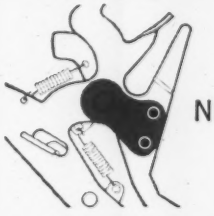
Two operators assembled 2 solid rivets and 1 shouldered stud into countersunk holes of trip pawl, placed this on a tray, then placed carrier arm over stud. Third operator positioned bearing plate over rivets and stud, lifted the loose assembly from the tray and slid it under a staking machine to stake the 2 rivets.



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Development and characteristics of

Pneumatic Actuators

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Director of Research
Conoflow Corp.
Philadelphia, Pa.

PRODUCTS and processes which use pneumatic actuators require that these components meet continually higher performance standards. In response, methods of producing restoring forces within the actuators have improved rapidly. Recent developments include the use of reversing relays, four-way valves, amplifiers, and boosters. This paper surveys the development of various methods leading to the all-pneumatic actuator.

A significant event in actuator design was the development of the pneumatic positioner. The actuator became a closed-loop position-type servo mechanism. It was applied to the existing spring and diaphragm motor with the result that the position error due to off-balanced forces was eliminated.

Despite this development, the use of a spring as a restoring-force member was not supplanted. The spring restoring force was eliminated by the development of the so-called "springless diaphragm actuator." In this design, the restoring force produced by the spring was replaced by fixed, regulated, air pressure to a sealed chamber on the underside of the diaphragm. An attendant development was the low-friction, high-pressure pneumatic cylinder.

The pneumatic restoring-force means, sometimes called the cushion-load system, allowed equal and adjustable force in both directions at any position of the stroke, Fig. 1. It resulted in relatively small actuators with tremendous force outputs. It also provided theoretically infinite stroke length although most applications are in 1 to 4-in. lengths. Some special applications have strokes as high

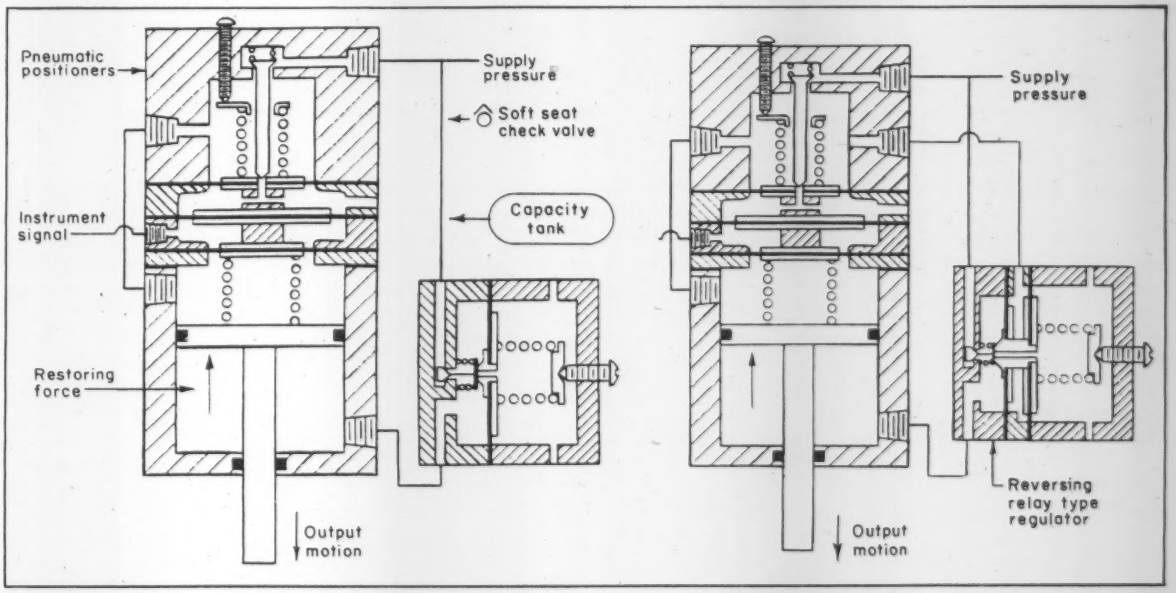

Fig. 1—Refinement of pneumatic actuators. Left, an actuator with fixed, regulated, air pressure restoring force. Center, a soft-seat check valve and a capacity tank are added in the pressure-supply line. They enable the assembly to fail safe in the up position. Right, a reversing relay in place of the cushion-load members makes 100 per cent of available force effective in either direction. Output pressure of the reversing relay is the exact opposite of the positioner output pressure.

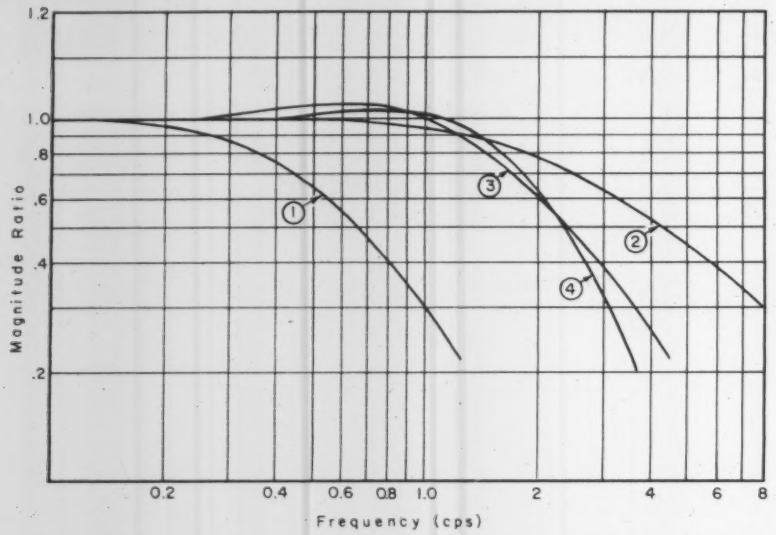

Fig. 2—Frequency response of a diaphragm actuator with positioner and booster. Data are: Supply pressure, 20 psi; cushion pressure, 9 psi; signal pressure, 9 psi ± 2½ per cent. Curve identifications and corner frequencies are: 1. Spring return without positioner booster, 0.44 cps. 2. Spring return with positioner booster, 2.4 cps. 3. Cushion return with positioner booster, 1.65 cps. 4. Reversing relay return with positioner booster, 1.80 cps. These results neglect mass-acceleration.

as 2 ft.

Pneumatic actuators have a fail-safe feature, the same as spring-type actuators. Sometimes called an "airlock" system, it uses an accessory capacity tank, a check valve, and a soft-seated regulator, Fig. 1. Another system uses two piloted soft-seated locking valves.

Spring - and - diaphragm systems have linearity errors up to 10 per cent. The constant-area cylinder incorporating a pneumatic restoring force and a precision pneumatic positioner incurs linearity errors as low as ½ per cent.

In many valve applications, the cushion-load pressure is quite often set to 10 per cent of the supply pressure. In this case, the total force in one direction is 90 per cent of the potential, and the force available in the reverse direction is 10 per cent of the potential. It would be desirable to have 100 per cent of force available in both directions. This has been accomplished by the application of a reversing relay in place of the cushion load, Fig. 1.

In the reversing relay, the output flow and pressure are controlled not only by the pressure deviation from the set-point, but also by the output pressure of the positioner. At-balance conditions are such that half the supply pressure is applied by the positioner to one side of the piston, and half of the supply pressure is applied by the reversing relay to the other side. When a load is applied to the stem of the actuator, the total output force is 100 per cent in either direction.

A characteristic used to express the ability of an actuator to provide power is load stiffness, expressed as per cent stem deviation upon application of a given load for a given-sized actuator under the same pressure conditions. Load stiffness, using a reversing relay, is twice as high as an equivalent cushion-load actuator.

Application of servo-mechanism theory to the pneumatic field allows the designer to derive the equations to show the direction to be taken to obtain faster responses. The equations indicate that the reversing relay gives faster response than the cushion-load system by a factor of one-half but with one ultimate limit equal to the spring system. Considering just the effect of the pneumatic restoring force, the problem is to decrease the resistance of the regulating device.

One method is to use the regulating device as is, but have it pilot a one-to-one ratio relay of greatly increased flow capacity. For this method, a flow booster is now available which also incorporates rate action. This rate action is adjustable and provides the user with a method of turning an actuating device to stable maximum speed.

The addition of a booster to the fixed regulator to increase the flow capacity resulted in increased response, although still not as good as the spring. In addition to increasing the frequency response, higher flow capacity also increased full stroking speeds.

Another factor greatly affecting the ultimate response of a pneumatic actuator is the flow sensitivity of the pneumatic positioner. Here, the flow booster already mentioned can be applied between the positioner output and the power device to increase the over-all flow capacity, Fig. 2.

Up to this point, the effect of mass-acceleration has been neglected. In any actuator, this effect will be encountered whether it is from the weight of the parts of the actuator, or the mass of the load. The effect on a pneumatic system is to create a very drastic instability such that the frequency response by design must be less than the natural resonant frequency of free oscillation. The pneumatic restoring force system affords the opportunity of a higher response because of the inherent damping characteristics of the regulator in the system.

Earlier, it was stated that a restriction of the air on the underside of the piston or diaphragm caused the speed of the actuator to be sacrificed and the ultimate response obtainable was when no restriction was offered at all. An alternate method to accomplish this minimum restriction, and still not use the spring as a restoring-force means, is the use of a double-area cylinder. Full air pressure supply is applied to the under-side of a piston whose area is one-half that of the top-side of the piston. By eliminating flow restriction, the designer has realized the possibilities of increased speeds.

A disadvantage of this type of system is the fact that the power

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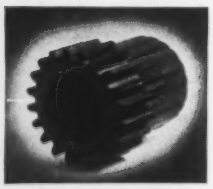

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output available, or the level of forces in either direction, is fixed by the area of the piston, and its versatility is restricted to a certain degree.

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Paper 20-59 presented at the 14th Annual Instrument - Automation Conference, Instrument Society of America, Chicago, Sept. 21-25, 1959, 10 pages.

Effective Controls Of Engineering

J. S. SAYER, Engineering Service Div., Du Pont

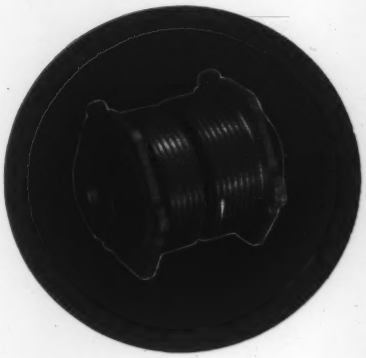
TWO tools for better control of the engineering function are: 1. Improved flow of information. 2. Improved manipulation of information by formal disciplined means.

Flow of information is a major aspect of the general term "documentation." The first step for improved documentation is to develop improved methods of indexing and putting information away.

All information-handling systems currently in use or under development are modifications of three facets of documentation: Classification, conventional alphabetical indexing, and concept co-ordination. It has been demonstrated that concept co-ordination is the documentation principle most adaptable to long-term technical needs.

Concept co-ordination indexes can exist in many forms. The choice is determined largely by economics. The larger the collection of information, the more numerous the questions, the shorter the desired retrieval time, the higher will be the cost.

vibration isolators



control vibration over full frequency range

MB ISO-DAMP* mounts do what a conventional isolator cannot. They isolate at both low and high frequencies. Protecting the precision of airborne sighting mechanisms, they not only have the required softness, but also a damping mechanism that restricts resonant build-up to under 3.5 to 1 in any direction.

MB concentrates on standard mounts which are actually in the special performance class. If you have a problem, avail yourself of our 20 years of experience. Send for Bulletin 616A which tells more.

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Circle 509 on Page 19

As one answer to the second part of the control theme, Du Pont has resorted to the "arrow convention." This has proved to be a very effective tool because, when anyone is required to carefully state the logic of a problem in detail, previous errors in judgment or overlooked factors are found and corrected.

The logic problem is to state how the several elements of work fit together to complete a job. Let an arrow represent each element, then connect the arrows in a fashion to show that for any one job what arrows, or work, must precede it and which must follow it, and how they are related. To complete the logic, show certain interconnections, and for this purpose, use broken-line arrows. This procedure completes a statement of a plan for a project. This is a simple rigorous technique that adds assurance against omissions and resolves the problem of job method. Also, incorporated in the plan are all job restraints that we know of and which are beyond our direct control.

Now introduce elapsed time for completion of each unit job. The problem is to solve for a schedule determining the time limits for each job and identifying the critical jobs such that the logic of the plan is never violated. Time and cost variations can be introduced to calculate a whole spectrum of schedules if we wish to expedite certain parts of the work independently.

If management wishes a reduced shutdown period, by putting time pressure on the arrow diagram, project time is shortened in such a manner that any decrease in time will be at a minimum increase in cost. This is a complex problem, involving a much higher order of mathematics and computation than the previous problem. Two approaches that can be used are: 1. A linear approximation of the time cost variation of each arrow. 2. A piece-wise linear approximation if more refined input data are desired.

In addition to work elements, either approach might show such items as delivery dates for equipment, drawing dates, construction equipment dates, start-up requirements, and many other restraints. This technique has been devised so that input information can be de-

vibration isolators

stand up in severe service

This Isomode® Type 5 mount is successfully isolating engine of Allis-Chalmers HD-6 Crawler Tractor. It survives severe shocks, rough motions, distortions, bursts of power and high engine torque inherent in operation of tractor dozers.

With a core in balanced compression and shear, the compact mounts have high load capacity, and are self-snubbing against shocks. Having equal spring rate in all directions, the mounts equally isolate the 6 possible modes of vibratory motion.

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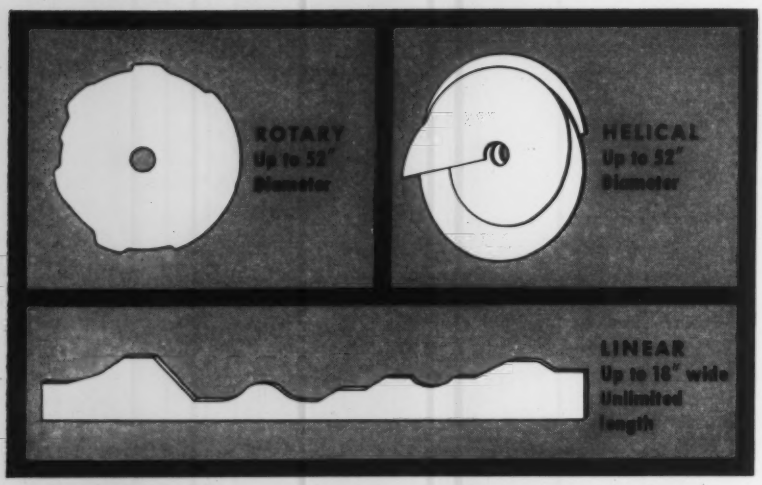

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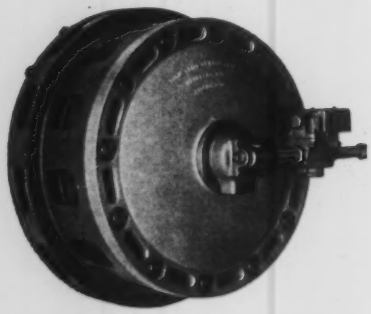
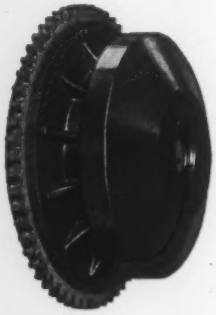
Circle 511 on Page 19

A Quality Line of Air-Operated Clutches

For General and Special Applications



This "LK" Clutch is engineered for high production. It never needs adjustment and combines the lowest inertia of driven parts with exceptionally high torque capacity. Complete range of sizes — 3,300 to 860,000 lb. in. torque ratings.



Our single and multiple disc Gear Tooth Clutches for general industrial use have low power losses, low upkeep, and long life. Air-engaged, spring-released — adaptable to remote control.

Our line of Superior Quality Clutches and Brakes includes also spring-loaded and over-center types, and clutches designed for operating conditions not satisfied by available types. Write us at Box 118, Waukesha, Wisconsin or Telephone LIberty 7-3359.

INDUSTRIAL CLUTCH CORP.

Waukesha Wisconsin

Circle 512 on Page 19

veloped and placed in the arrow diagram by first-line supervision.

ASME Paper No. 59-MGT-8, "Some Aspects of Control of the Engineering Function," presented at the ASME-AIEE Engineering Management Conference, Los Angeles, Sept. 17-18, 12 pages.

Nine Guides in Design For Reliability

B. BRADFORD RICHARDSON, Norair Div., Northrop Corp.

PERFORMANCE demanded of complex products, particularly aircraft and missiles, emphasizes the importance of the reliability of all systems. The greatest single factor for the attainment of this reliability is in simplified system design. With the advent of missiles, where mechanical failures are generally catastrophic, a new philosophy has been developing for the designers of systems components large and small. Smallest points are:

1. **Provide for absolute mechanical simplicity.** Every element of the system which is not "absolutely reliable" should be challenged, to eliminate it, simplify it, or otherwise improve its reliability. Absolute reliability may be taken to be less than one failure in 10,000 parts.

2. **Eliminate excess components.** Make sure that each component cannot be eliminated by change in system configuration or in specified requirements or design conditions. Re-examine, rearrange and eliminate. The only sure way to make equipment absolutely reliable is to remove it from the system!

3. **Use simple mechanisms.** They are more reliable than complex ones. The ultimate is no moving parts. Avoid delicate hardware. Avoid flow passages small enough to clog with contaminant. Close clearance sliding fits are generally to be avoided.

4. **Use functional equipment which is already in quantity production.** It is more reliable than equipment developed and built especially for a system.

5. **Design system to have liberal performance margins,** rather than just adequate. Distribute performance margins among related functions to avoid a relatively weak link. Avoid difficult-to-accomplish physical functions, such as low-volume leakage.

6. **Make reliability the major design requirement.** Liberal performance margins provided by the system design shall not

be wasted by allowing loose performance requirements in the equipment design specifications.

7. **Provide for checking every vital function** of every component after assembly is complete. Design so that physical interference prevents misassembly or misinstallation which is not readily obvious.

8. **Minimize vital-complex functions.** "Vital functions," defined, must take place for a mission to be completed. "Complex functions," defined, are operations of complex mechanisms.

9. **Minimize vital human functions.** "Vital human functions" means operations which must be performed by people, which require any degree of human judgment or memory, and which must be accomplished properly to complete a mission.

SAE Paper No. 101U, *"Design for Reliability," presented at the SAE National Aeronautical Meeting, Los Angeles, Oct.* 5-9, 1959, 8 *pages.*

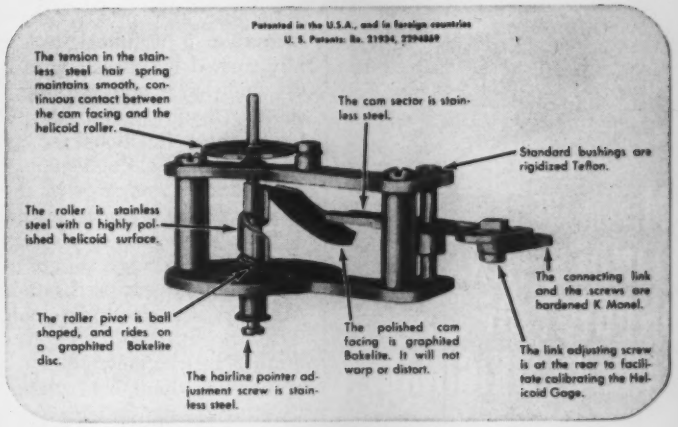
Publications for Defense Products

LOUIS H. SPRUNG, Admiral Corp.

OPERATIONS of an engineering publications group in a company developing weapons systems under govermnent contract. For any product, the minimum necessary output of the design function is a set of drawings, a bill of material, and an assembly and testing procedure. This data is sufficient to enable a product to be manufactured. For weapons systems, additional output of logistics data and handbooks enable a device to be maintained. Long-term maintenance of reusable weapons is based upon two concepts: Logistics, and education. Logistics has its beginning in "provisioning," which is partly the process of providing a maintenance item where and when needed. Education entails creating a document to explain how a product works, how to find its points of failure, and how to make repairs.

Differences in the missions of the several services cause entirely different organizations and logistics procedures. For electronic equipment, data that the services must have to set up logistics procedures are set down in these specifications:

Bureau of Ships	MIL-M-17362
Bureau of Aeronautics	SAR-400



Exclusive Helicoid movement provides...

Sustained Accuracy... on the toughest jobs

• Helicoid Gages have no gears, no teeth, reducing wear to an absolute minimum. No danger of fouling, either—rolling action of cam facing keeps contact surface clean. Helicoid Gages have been tested through 75,000,000 cycles, with virtually no wear or loss of accuracy, while conventional geared gages became useless after 500,000 cycles.

Helicoid Gages give *sustained* accuracy even when subjected to violent pressure pulsations or mechanical vibrations. Pointer can be set externally, without removing glass, and cannot be jarred out of position. Dial faces are easy to read, won't corrode or chip. A full range of Helicoid Gages is available for any application. Next time, specify Helicoid—the gage that *stays* accurate.

Bourdon Tubes won't Stretch, Leak, or Crack

Helicoid Bourdon tubes are made from seamless tubing, and are designed for maximum torque and minimum stress. At the factory, each tube is individually tested, overpressured, and stress relieved. Four materials—alloy steel, K Monel, stainless steel, and phosphor bronze—are available to meet applications ranging from tap water to almost any acid.

NEW! Solid-Front Safety Case Gives Added Protection

The new Helicoid solid-front case diverts the force of a burst in a backward direction, away from the operator. The force escapes by deforming, though not detaching, the back cover plate. Helicoid Gages are also available in phenol, acaloy flanged, acaloy flangeless, polished flangeless, round flush, polished flush ring, and square flush cases.

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By fitting into one-third less space than a tie-rod cylinder of the same bore, this original O-M space-saving component gives greater flexibility to design, reduces weight and cuts installation time.

But there are many other reasons for using this O-M Round-line Cylinder that delivers smooth, dependable power. It has the lowest coefficient of friction . . . assures full-power starts . . . is sealed right—ports are easily oriented independently to 360 degrees . . . and, end plugs are tapped for universal mounting. Easily modified for special applications at a nominal extra over standard cylinder prices. Internal locking key makes it easy to disassemble, service and reassemble with no alignment problems.

Available for Air or Hydraulic circuits in a complete range of sizes (1⅛" to 8" bores) with standard, 2 to 1 or oversize rods. All-steel construction with bearing bronze. Completely interchangeable parts. Immediate delivery on many sizes.

Mail coupon at once for Bulletin 101A containing engineering drawings of cylinder, mounts, mounting brackets, capacity chart and other data.

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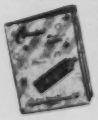

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Circle 514 on Page 19

Signal Corps	PP-SIG-SE-1A
Marine Corps	MIL-M-17993C
Air Force	MCP 71-649, -650, -673

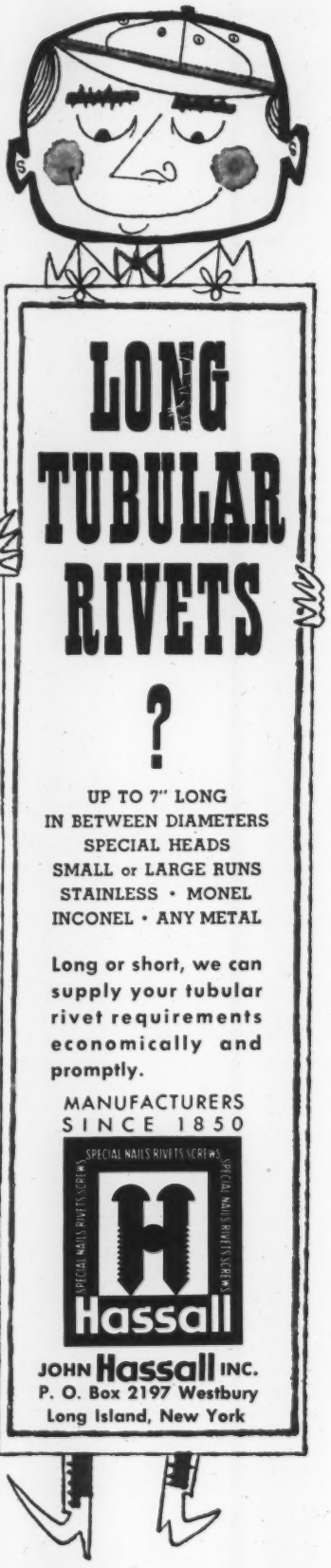
Because the provisioning documentation is technical, it is generally created by persons with technical knowledge and training in the specific requirements. At Admiral Corp. these functions are assigned to Engineering Publications Dept.

Publications required by the services vary with organization and use: 1. The Navy Bureau of Ships generally requires two copies of a Technical Manual per Specification MIL-M-16616, for electronic equipment. These books contain sections on operating instructions, theory of operation, overhaul instructions, service instructions, performance standards, and maintenance parts lists. 2. The Air Force and the Navy Bureau of Aeronautics generally organize their requirements into several separate handbooks. They cover the subjects of installation, flight instructions, operating instructions, service instructions, overhaul instructions, and illustrated parts breakdown. 3. The Signal Corps generally prints its own books and controls the distribution thereof. They usually require only finished art work and typed manuscripts. Maintenance and repair capabilities of the Army vary with echelons, and so do handbook requirements.

Handbooks are generally required by the services to be delivered simultaneously or before the first production deliveries of new equipment. Therefore, handbook writing must take place while the equipment is under development and test. This is why handbook writing can be considered a part of the design process. Frequently, clarification of engineering problems occurs to the designers when a good publications engineer is associated with the job.

Other products of a publications group are technical proposals and engineering reports. Technical proposals outline the manner whereby a system or equipment would be created by the contractor. Technical proposals must frequently accompany cost proposals. Research and development contracts generally require monthly letters of progress, quarterly reports, and final reports. Engineers supervise composition.

ASME paper, "The Relationship



Circle 515 on Page 19

between Design Engineerng and Engineering Publications," presented at the ASME-AIEE Engineering Management Conference, Los Angeles, Sept. 17-18, 1959, 12 *pages.*

bearings

Bearing Selection

A. O. DeHart, General Motors Corp.

Selection and application data for fluid-film and rolling-contact type bearings. Emphasis is on externally pressurized bearing types which show promise in many applications. Tables compare pertinent selection factors.

ASME paper 59-MD-12, Design Engineering Conference, Philadelphia, May, 1959; 12 *pp.*

materials

Applications of Ceramics and Glass

L. Zagar, Technische Hochschule, Aachen, Germany

A report on the development of silicates and their application in the field of aeronautics. Glass, ceramics, and oxyceramic materials are covered, and their properties discussed in detail.

NATO Report 179, *Seventh Meeting of the Structures and Materials Panel, Rome, Italy;* 15 *pp.*

Tensile Strength of Alloys At High Rates of Strain

Arthur L. Austin and Robert F. Steidel, Jr., Univ. of Calif., Livermore, Calif.

Dynamic tensile properties of materials determined by an experimental method. Loads are applied by an explosive-impact tension tester which has provisions for direct measurements of load, impact velocity, and instantaneous changes of diameter as a function of time. A charge of gunpowder is used to propel a projectile which is threaded to one end of a standard tension specimen, the other end being fixed.

The fracture strengths, per cent reduction of area, and per cent elongation for SAE 1018 cold-rolled steel, 6061-T6 aluminum alloy, and C120-AV, A110-AT, and A55 titanium alloys have been obtained for

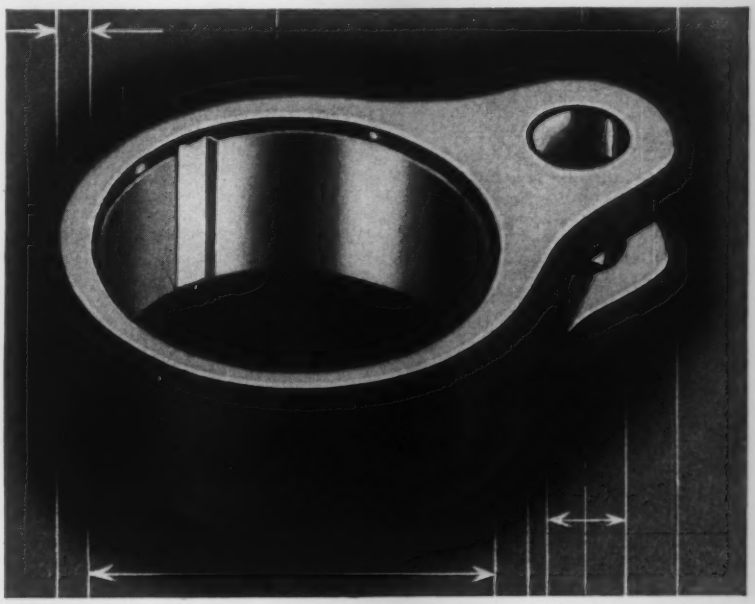
exceptionally close limits...

The photograph shows the connecting rod of an unusual hydraulic pump built by a company whose name is known everywhere.

The finish in the bore of both the large hole and the small hole must be held to very fine profilometer reading.

In addition, the axes of these two holes must be parallel to each other within exceptionally close limits. Naturally, the user of a cast bronze part such as this turns to Bunting in order to assure strictest adherence to his print and specifications.

For the unusual, as well as the usual, in bearings, bushings, bars, or special parts of cast bronze, sintered bronze, or Alcoa aluminum, try Bunting first.



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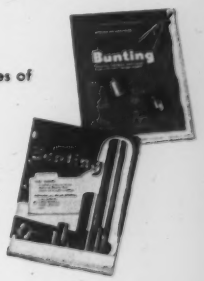
Bunting's "Engineering Handbook on Powder Metallurgy" and Catalog No. 58 listing 2227 sizes of completely finished cast bronze and sintered oil-filled bronze bearings available from stock.



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Circle 516 on Page 19

ADVANTAGES OF FLEXIBLE SHAFTING

For Power Drive and Remote Control

by

C. Hotchkiss, Jr.

Application Engineer

Stow Manufacturing Company

Flexible shafting has the following advantages over other type drives:

1—it is often the simplest method of transmitting power between two points which are not collinear or which have relative-motion.

2—eliminates exposed revolving parts

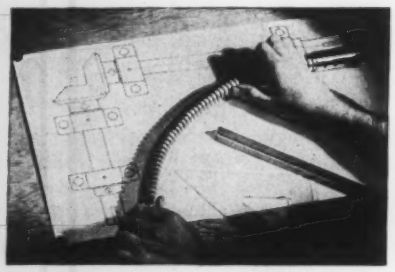
3—does not require accurate alignment

4—easy to install and maintain

Not Collinear—Where it is necessary to connect two shafts which are not collinear, a simple arrangement of a single belt or two universal joints will often do the job adequately. But, in many cases where the path of transmission is more complicated and would require a more expensive arrangement of mechanical components, flexible shafting provides a simple, low cost, efficient drive which is easy to install because it does not require accurate alignment. See example, figure 1, in which a 1¼-inch Stow flexible shaft is used to drive the auger on a G.L.F. bulk feed truck.

Flexible shafting also allows the designer greater freedom in locating either the drive or the driven component on a piece of equipment.

Fig. 1



Relative Motion — Where two shafts which have relative motion must be connected, flexible shafting is often the ideal means of transmission. In many cases it eliminates a much more complicated drive which would, necessarily, include telescopic joints; further, it eliminates the danger of exposed moving parts. See figure 2, which shows a ¾-inch Stow flexible shaft driving an Avery Rake built by the Minneapolis Moline Co.

Fig. 2

Other typical applications of this type are used on portable power tools when motors are too heavy to be mounted on the tool—such as portable grinders, sanders, paint scrapers, saws and tree tappers. And, since flexible shafting is not affected by vibration, it is an ideal drive for applications where a high degree of vibration is involved—such as in vibration testing tables and concrete vibrators.

Stow flexible shafts are available: for power drive applications in diameter sizes from ⅛-inch to 1¼-inches; for remote control applications in diameter sizes from ¼-inch to 1⅝-inches. The 1¼-inch power drive shaft will transmit up to 10 HP while the 1⅝-inch remote control shaft will transmit up to 4000 lb. in.

For complete engineering data on flexible shafting, including selection charts, write for engineering bulletin 570.

STOW MANUFACTURING COMPANY

11 SHEAR STREET • BINGHAMTON, NEW YORK

strain rates up to 22,000 per sec at room temperature. It is concluded that in general the dynamic strength and ductility of these materials increase with increasing strain rate.

ASTM Paper No. 81, presented at the 62nd Annual Meeting, June, 1959, 15 pages.

New Developments in Metals And Ceramics for Use Above 10

J. J. Harwood, Office of Naval Research

A comparative evaluation of materials with respect to their high-temperature capabilities, potentialities, and limitations. A general survey of high-temperature materials includes properties and applications of the light alloys, superalloys, refractories, cermets and ceramics, and composite materials. A forecast of future trends in materials research and development is included.

ASME paper 59-MD-2, Design Engineering Conference, Philadelphia, May, 1959; 12 pp.

New Elastomers

R. P. Schmuckal
Ford Motor Co.

Condensed information on new elastomers, giving molecular structure, advantages and limitations, some current and potential applications, and prices. The new elastomers are compared to existing materials, and fitted into their places in the general order of elastomers.

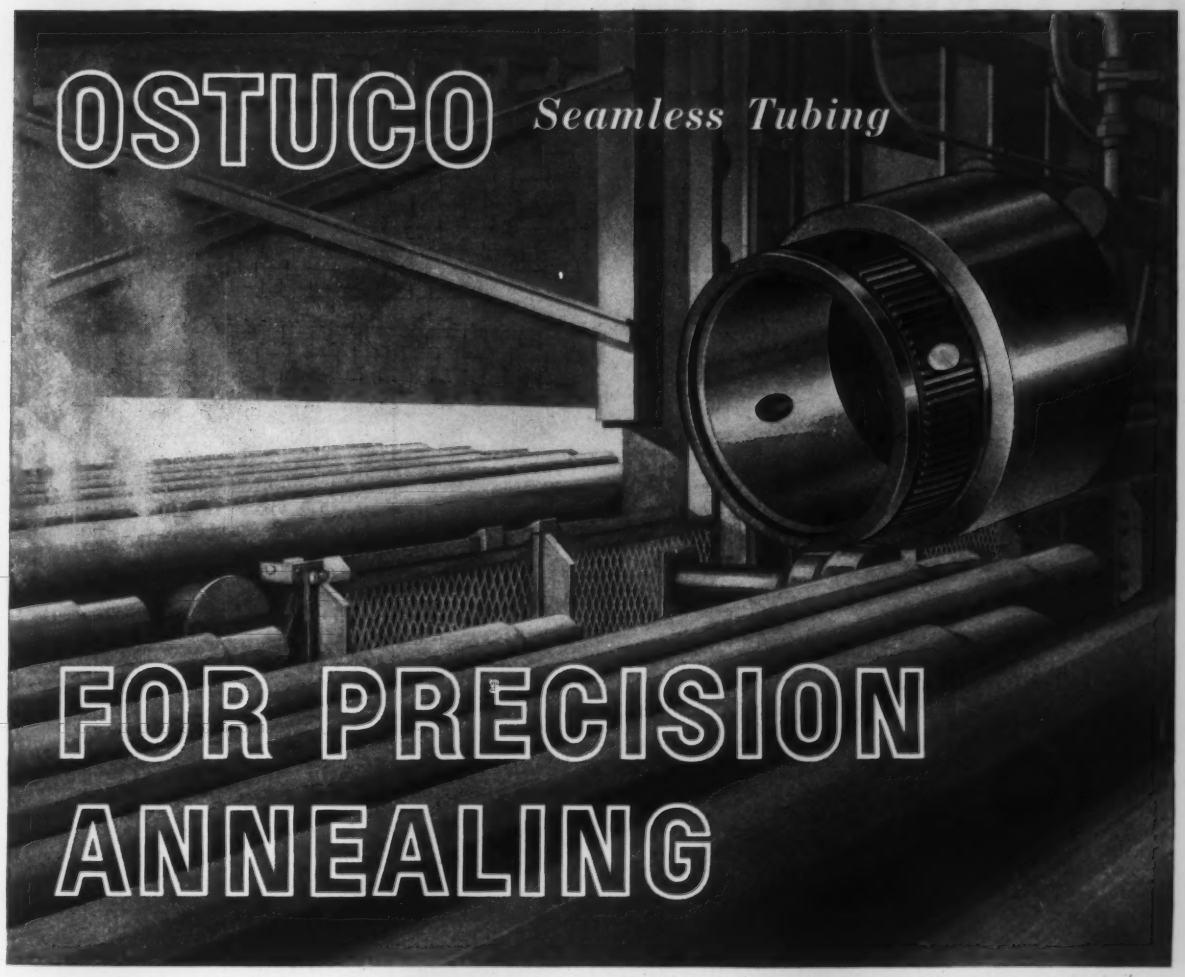
SAE Paper No. 82U presented at the Summer Meeting, Atlantic City, N. J., June, 1959, 20 pages.

High-Temperature Plastics For Use Above 1000 F

I. Gruntfest, General Electric Co.

An analysis of thermal conditions met in high-speed applications of high-temperature plastics. Four stages that the material being heated may experience are: 1. No temperature gradient at the surface. Heat input is exactly balanced by radiation from the surface. 2. Equilibrium temperature above the melting temperature of material at which melting begins and a slow recession of the surface takes place. 3. Sufficient heat to cause vaporiza-

Automatic Transmission Manufacturer Specifies



Annealing furnace at the Shelby mill. Ostuco tubing can be bright or soft annealed, stress relieved, normalized or heat treated.

"As a leading producer of quality transmission components, we can't leave anything to chance. Our design requirements, materials specifications and manufacturing processes are under the most stringent quality control standards. And we demand as much of our vendors.

"One sure way we have found to eliminate the unpredictable is to specify Ostuco Seamless Tubing. We know from experience we can rely on the precision annealing and unvarying quality of Ostuco tubing that slashes reject rates, helps us produce parts in quantity for profit . . ."

If you want to eliminate the unpredictable in your own plant, then it's time you called your local Ohio Seamless representative. He's listed in the Yellow Pages. Or contact the plant at *Shelby, Ohio —Birthplace of the Seamless Steel Tube Industry in America.*

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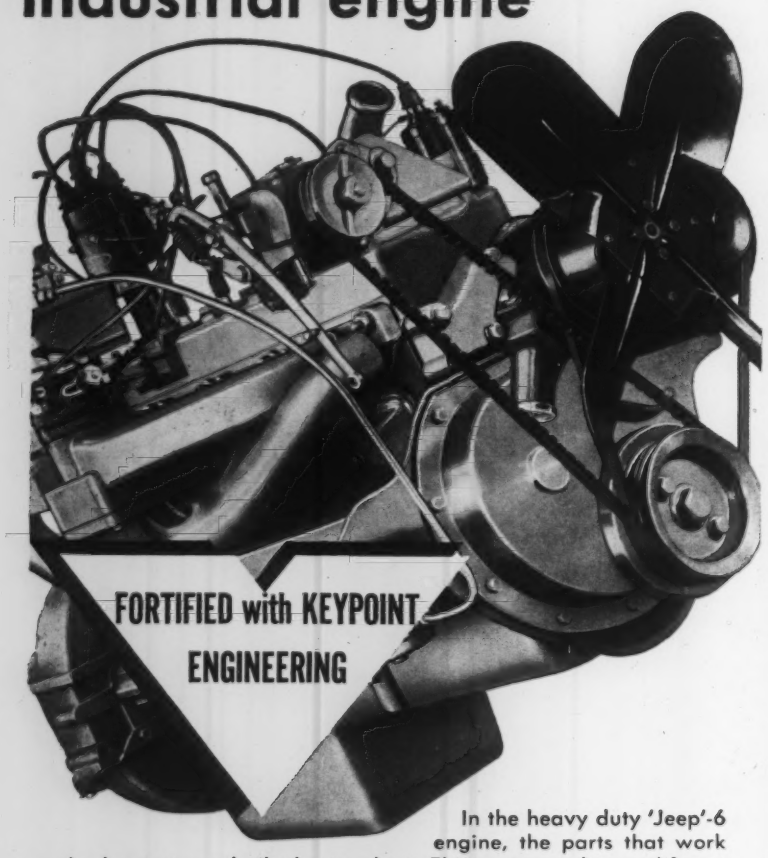
THE ENDURING 'Jeep'-6 industrial engine



In the heavy duty 'Jeep'-6 engine, the parts that work the hardest are built the toughest. This means a longer life, at maximum efficiency, for all industrial uses requiring 32 to 65 **continuous** duty horsepower. A special high-torque camshaft produces 143 ft/lbs for **continuous** duty at 1200 rpm, and still delivers 132 ft/lbs at 2600 rpm! This performance is fortified by Keypoint Engineering for extra long life!

KEYPOINT FEATURES INCLUDE:

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1. FOUR RINGS . . . including a Hard Chrome-faced Compression Ring and a Hard Chrome-faced Steel Rail Oil Ring.
2. ALUMINUM ALLOY PISTONS . . . are hand fitted for exact tolerance.
3. NEW CONTROL BAND . . . reduces the possibility of piston slap and skirt collapse.

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1. HARD FACED VALVES . . . of Stellite or Eatonite.
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3. POSITIVE VALVE ROTATORS . . . keep valves free and clean.

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1. HEAVY DUTY BEARINGS . . . of Moraine Durex.
2. FORGED CRANKSHAFT . . . statically and dynamically balanced.
3. 100% COUNTERWEIGHTED . . . for smooth, quiet operation.

PUT THE 'JEEP'-6 TO WORK FOR YOU — WHEREVER YOU NEED DEPENDABILITY

KAISER WILLYS MOTORS

WILLYS MOTORS, INC.
Industrial Engine Dept., Toledo, Ohio

tion of the plastic material. 4. Chemical reactions. Materials include phenolics, graphite, Teflon, glass-reinforced phenolics, and other plastics of the thermosetting type.

ASME paper 59-MD-1, Design Engineering Conference, Philadelphia, May, 1959; 16 pp.

processes

Effect of Residual Welding Stress on Brittle Fracture

Hiroshi Kihara and Koichi Masubuchi, Tokyo, Japan

An experimental investigation of the effect of residual welding stress on brittle fracture. It was found that residual welding stress, having no effect on the ductile fracture of welded structure, may play an essential role in the case of brittle fracture. The complete fracture of a welded joint may be produced by merely applying low stress in a static manner when such unfavorable conditions as the use of materials of low notch toughness, existence of sharp notch, and high-tensile residual stress are accumulated.

The effect of preloading at high temperature on the behavior of a joint was also investigated. It was found that the preloading produces favorable effect on the fracture strength at low temperature.

AWS paper presented at the 40th Annual Meeting, Chicago, April, 1959, 9 pages.

mechanical

Development of High-Temperature Strain Gages

R. Bertodo, C. C. Bowring Ltd., London

A review of the work carried out in developing a strain gage capable of operating at temperatures to 1832 F with an inherent accuracy of ±5 per cent. A large number of resistant alloys were tested as unbonded long wires at room temperature. A small number of these were selected for further testing in the form of gages at high temperatures. Effects of factors such as metallurgical changes, geometric shapes, and long-term exposures on behavior of the gages are considered. Bonding media, some commercially available, are examined with particular reference to

Design Data on Resilient Clutch Facings

#6

THE EFFECT OF FACING DENSITY ON CLUTCH PERFORMANCE

A prime consideration in clutch design is how to maintain the performance characteristics throughout the life of the clutch.

One factor which must be considered in this respect is compression set or "packdown"—a permanent compression of the facing material which occurs during operation. Compression set is most likely to occur where facing pressure is high and the density of the material is low.

Effects of compression set

Sometimes compression set is mistaken for wear. Actually, it does not shorten the life of the material. But it may have two effects which are undesirable. First, it decreases the thickness of the facing. In a clutch pack consisting of many plates, this may mean the piston stroke is not long enough to compensate for the loss in thickness, and slippage will result. Second, compression set increases the density of the facing material. As shown in Figure 1, it is possible that this increase in density will lower the coefficient of friction significantly.

Naturally, where compression set occurs and alters the coefficient of friction, the engagement characteristics of the clutch will be altered. So, to maintain the desired performance characteristics, it is necessary to control the density of the facing to minimize compression set.

Controlling compression set

Figure 2 shows how this can be accomplished in a certain clutch with a facing pressure of 150 psi. In this test, when the facing was compressed during bonding to a density of 36 pounds per cubic foot, it took a compression set of almost 15% in service. But with a facing compressed to 60 pounds per cubic foot density, no further compression set occurred. Because this particular fiber facing can be bonded to a plate at densities up to 60 pounds per cubic foot, serious compression set can be avoided at the desired operating pressures.

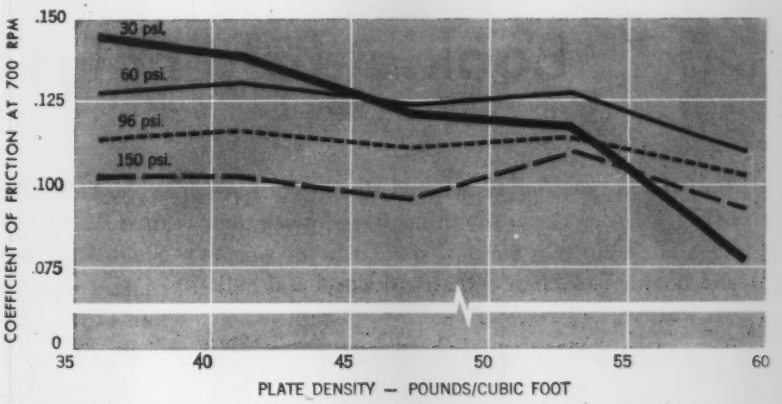


Figure 1. This chart shows the relation of plate density to coefficient of friction at 700 rpm and with various facing pressures. Data were accumulated in specific tests run at the Armstrong Research and Development Center, using a flat, plain plate with facing dimensions of 6¼" I.D. and 7½" O.D. in Type A transmission fluid at 200° F.

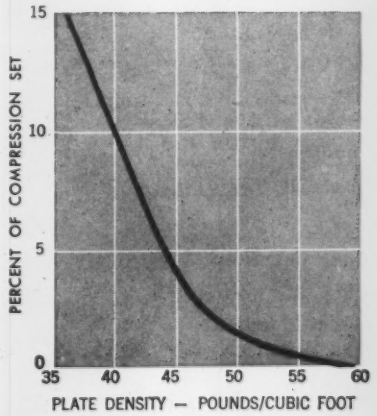


Figure 2. This graph shows the per cent of compression set incurred with facings of various densities. A typical fiber facing, 6¼" I.D. x 7½" O.D., was used on a flat, plain plate at 1000 rpm with 150 psi facing pressure. The facing was submerged in Type A transmission fluid at 200° F. The graph shows the per cent of compression set after a minimum of 3000 cycles.

Maintaining engagement characteristics

It is possible to determine the density necessary to avoid compression set for any Armstrong fiber facing under given conditions. And, if the facing is used at that particular density, engagement characteristics will not be altered by compression set.

Armstrong fiber facings can be obtained in a wide range of densities by varying the amount of compression during the bonding operation. Thus, with these facings, the clutch designer can gain the optimum combination of plate density and coefficient of friction for his particular application. Your Armstrong man will be glad to help you select the right facing and the proper density for your clutch.

• •

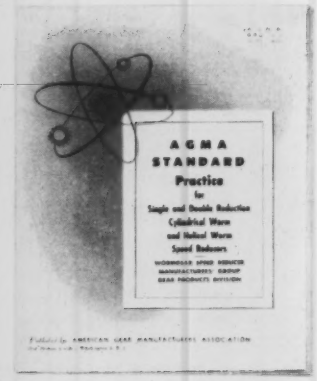
For assistance in solving a problem involving friction materials, send complete details of your application to Armstrong Cork Company, Industrial Division, 7211 Dean Street, Lancaster, Pennsylvania.

Armstrong RESILIENT FRICTION MATERIALS

... used wherever performance counts

DE LAVAL offers new A.G.M.A. Gear Standards Booklet for Engineers

You will not want to be without this newly published American Gear Manufacturers Association booklet. It outlines the new standards for single and double reduction cylindrical worm and helical worm speed reducers.



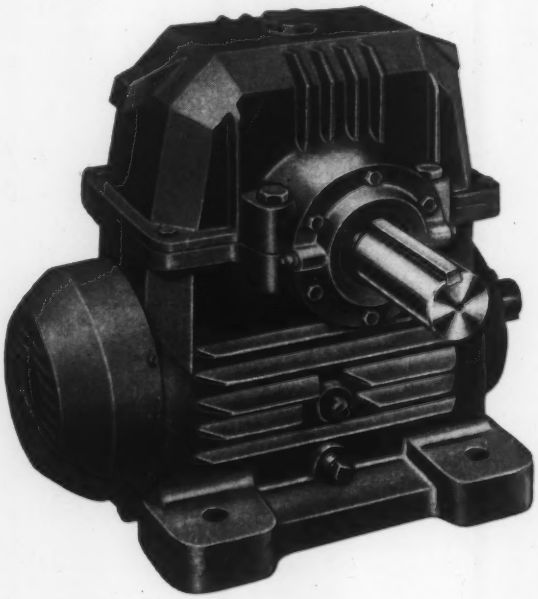
Get this new A.G.M.A. 440.03 booklet free of charge by request on your company letterhead.

This new standards booklet contains important design data including: Power rating of worm gears • Ratio correction factor (Km) • Materials factors (Ks) • Velocity factor (Kv) • Coefficient of friction (μ) • Thermal factor • Service factors • Efficiency • Overhung load capacity • Lubrication.

The materials factor (Ks) and the coefficient of friction (μ) are new, reflecting the latest advances made in worm gearing in the past few years.

We have also recently published our new Delroyd Worm Gear Sets Catalog 3800 and Delroyd Single Reduction Worm Gear Catalog 3805, which contain comprehensive information on the selection of these units.

De Laval furnishes worm gearing under the trade name DELROYD and has a complete line from $1\frac{1}{8}$" to 36" center distance, in horsepower ranges from .04 to 700 and in ratios from 5: to 4900:.



DE LAVAL *Steam Turbine Company*

858 NOTTINGHAM WAY, TRENTON 2, NEW JERSEY

DL-482

creep under load, shear strength, and resistance to erosion and thermal shock. Any factor affecting resistivity of the gage also affects sensitivity.

The most significant result obtained during the test is that the gage factor may be predicted with ± 5 per cent in any given temperature, provided certain precautions are observed. Typical failures under field conditions are discussed with the possibilities of operating for protracted periods under steady stress conditions. Requirements for future applications suggest that the wire strain gages are unsuitable because of their low resistance in very small sizes. An alternative is outlined.

Prepared for the Institution of Mechanical Engineers (Great Britain); 14 pp.

Starting Systems For Jet Engines

H. R. Schmider and J. H. Ferguson Jr., Bendix Aviation Corp.

A general treatise on self-contained starting systems and related equipment for turbojet and turboprop engines. Equipment available for use includes the direct-impingement system, the pneumatic starter, the pneumatic starter with combustor support, the fuel-air combustion starter, the solid-propellant starter, liquid-monopropellant starters, hydraulic starters, and electric starters. Description and operation of each type are covered. Economies and maintenance are also described.

SAE paper 48T, SAE National Aeronautic Meeting, New York, 1959; 27 pp.

TO OBTAIN COPIES of papers or articles abstracted here, write directly to the following organizations:

ASME—American Society of Mechanical Engineers, 29 West 39th St., New York 18, N. Y.; papers 25 cents to members, 50 cents to nonmembers.

ASTM—American Society for Testing Materials, 1916 Race St., Philadelphia 3, Pa.

AWS—American Welding Society, 33 West 39th St., New York 18, N. Y.

SAE—Society of Automotive Engineers Inc., 485 Lexington Ave., New York 17, N. Y.; papers 50 cents to members, 75 cents to nonmembers.

The Institution of Mechanical Engineers, 1 Birdcage Walk, Westminister, London, S.W., 1.

A reliable source of Cherry blind rivets and tools is waiting to serve you at the other end of your telephone line in more than 75 cities throughout the United States and Canada.

This network of Townsend jobber-distributors provides you with a ready inventory of self-plugging and pull-thru rivets together with a full range of hand and power-actuated setting guns and other installation tools.

In addition, the jobber-distributor in your area is qualified to give you expert assistance in selecting the proper size and style of rivet for your particular application.

Your jobber-distributor now stocks Townsend Cherry blind rivets in steel, aluminum alloy, Monel and copper—in 3/32", 1/8", 5/16", 1/4" and 5/32" diameters—in a wide range of grip lengths and a variety of head styles. For the name of the jobber-distributor nearest you, write to Engineered Fasteners Division, P.O. Box 71-E, Ellwood City, Pa.

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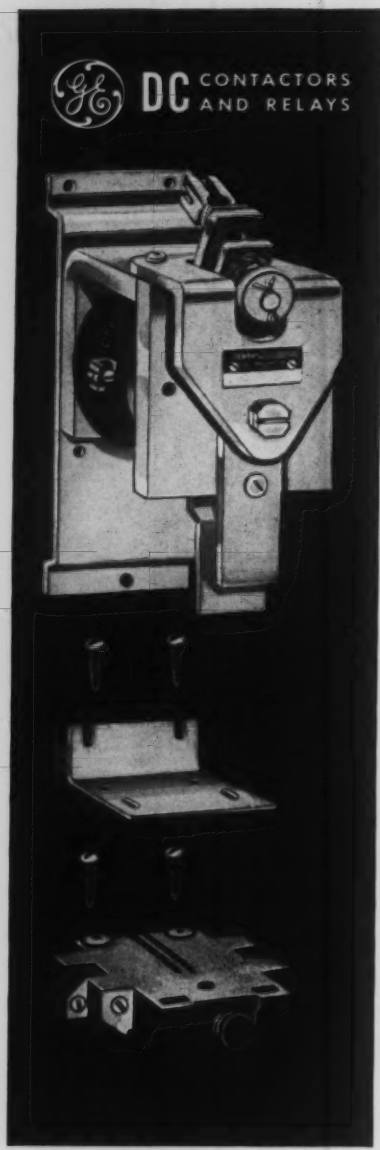
In Canada: Parmenter & Bulloch Manufacturing Company, Limited, Gananoque, Ontario

Circle 520 on Page 19



NEW BUILDING-BLOCK DC DEVICES

Assemble the exact contactor or relay you need—when you need it! General Electric's new "building-block" design allows quick, on-the-spot assembly of more than 100 different devices—from a few standard components. For all the facts, follow reader service instructions below. General Electric Company, Roanoke, Virginia. 784-19

Progress Is Our Most Important Product

GENERAL ELECTRIC

Circle 521 on Page 19

Helpful Literature for Design Engineers

For copies of any literature listed, circle Item Number on Yellow Card—page 19

Sintered Metal Parts

Quali-Sint process of producing sintered metal parts offers high strength and uniformity, plus low final costs, according to illustrated bulletin. Physical characteristics, mechanical properties, and applications are covered. 4 pages. Burgess-Norton Mfg. Co., Geneva, Ill. I

Circle 701 on Page 19

Trace Milling Attachment

Synchro-Trace automatic three-dimensional duplicating system, subject of illustrated Bulletin STM-1, is available in pre-engineered kit form for use on many small milling machines. It can also be installed on medium and large mills and planer type mills by the manufacturer. Details of its operation are given. 6 pages. True-Trace Sales Corp., 9830 Rust St., El Monte, Calif. L

Circle 702 on Page 19

Subminiature Switches

High temperature (650° F) and environment-free, metal encased switches, plus phenolic cased, pushbutton, toggle, and integral actuator subminiature switches are subject of illustrated Unimax Catalog 159. Pictorial index shows where to find dimension drawings, descriptions, force movement specifications, and electrical ratings for each switch. 16 pages. W. L. Maxson Corp., Unimax Switch Div., Ives Road, Wallingford, Conn. B

Circle 703 on Page 19

Plastic Parts & Shapes

Facilities available for supplying extruded shapes or precision parts from nylon, Delrin, or Penton plastics are detailed in Bulletin 9263. Both the properties of these materials and their applications are tabulated. 4 pages. National Vulcanized Fibre Co., 1059 Beech St., Wilmington 99, Del. C

Circle 704 on Page 19

Direct-Drive Blowers

Bulletins DD-154 and DD-173 are descriptive of two series of direct-drive blowers with Center-Lock or standard double Airotor wheels. Performance graphs aid in application and engineering. 4 pages each. Torrington Mfg. Co., Torrington, Conn. B

Circle 705 on Page 19

Speed Reducers

Guidance in the design, selection, and application of helical gear speed reducers is offered in Book No. 2751. Twenty sizes of In-Line reducers include double, triple, and quadruple reduction units with ratios as high as 2217 to 1 and ratings to 206 hp, depending upon the model. 20 pages. Link-Belt Co., Prudential Plaza, Chicago 1, Ill. J

Circle 706 on Page 19

Pipeline Strainer

Self-cleaning design is offered in type BT pipeline strainers for condensate, steam, water, oil, air, gas, and other fluid service. They can be used at temperatures to 450° F and pressures to 250 psi. Complete specs are given in Bulletin 1210-1. 2 pages. Sarco Co., 635 Madison Ave., New York 22, N. Y. D

Circle 707 on Page 19

Rotary Gear Pumps

Sizes and capacities for service ranging from 100 to 2000 psi with deliveries up to 145 gpm are included in the line of Nitralloy rotary gear pumps described in Bulletin 42. Listed are various fluids, including acids and alkalies, which can be handled. 4 pages. Northern Ordnance Inc., Minneapolis 21, Minn. J

Circle 708 on Page 19

Silicones

Bulletin 1-114 is entitled, "1959 Guide to Dow Corning Silicones." It lists properties of silicone fluids used as defoamers, release agents, paper coatings, cosmetic ingredients, and polishes; lubricants; resins and adhesives; dielectric compounds; silicone rubbers; and specialty products. Technical aid in product development using silicones is offered. 16 pages. Dow Corning Corp., Midland, Mich. H

Circle 709 on Page 19

Hydraulic Accumulators

Described in Bulletin 100 are various sizes of hydro-pneumatic accumulators for use in industrial, farm, and domestic hydraulic systems. Capacities range from 15 to 7500 cu in. for pressures to 2000 psi. 2 pages. Special Products Co., 15000 W. 44th Ave., Golden, Colo. K

Circle 710 on Page 19

Control Valve

The Model 235-1 adjustable-cam lever-operated control valve, detailed in illustrated catalog sheet, maintains accurate flow-pressure drop ratios for oil, steam, water, air, and gas pressures to 300 psi. It can be controlled remotely, if desired. 2 pages. Atlas Valve Co., 280 South St., Newark, N. J. D

Circle 711 on Page 19

IT PAYS TO STANDARDIZE ON **STANSCREW**

Stanscrew service helps insure precision of *Gilbarco* pumps

Gilbert & Barker Mfg. Company builds its famous Gilbarco gasoline pumps for oil companies large and small, and ships them to every state in the union as well as to most countries overseas. To insure precision and dependability of these pumps, great care must be taken in all assembly operations. Fasteners, for instance, must be torqued precisely to keep all components in perfect alignment.

Because of the critical importance of fasteners to its products, Gilbarco has selected Stanscrew heat-treated cap screws for such key applications as the positive displacement meter (shown in the insert). Stanscrew fastener specialists were happy to assist Gilbarco engineers in determining the right fastener with the correct torque to assure trouble-free service.

Gilbert & Barker is one of a long roster of honored names in American industry who have found it pays to standardize on Stanscrew. A product of unsurpassed quality . . . a broad selection of more than 5,500 different fasteners . . . prompt service through local distributors, backed by complete stocks at three conveniently located plants . . . these are a few of the reasons Stanscrew means greater value in fasteners.

Stanscrew's experienced fastener specialists can often suggest ways to improve your assembly procedures. Your local Stanscrew distributor will be happy to arrange a prompt visit. Call him today.

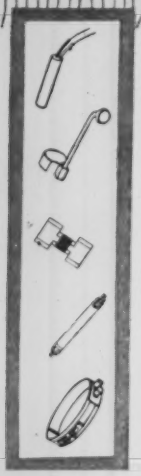
STANSCREW FASTENERS

CHICAGO | THE CHICAGO SCREW COMPANY, BELLWOOD, ILLINOIS
HMS | HARTFORD MACHINE SCREW COMPANY, HARTFORD, CONNECTICUT
WESTERN | THE WESTERN AUTOMATIC MACHINE SCREW COMPANY, ELYRIA, OHIO

STANDARD SCREW COMPANY 2701 Washington Boulevard, Bellwood, Illinois

Circle 522 on Page 19

Custom-Designed
ELECTRIC HEAT
by WATLOW



the WAY you want it...

Whatever type of electric heat your operation requires—submerged in a liquid, surrounding a solid, inserted within a solid, or across a flat surface—Watlow can design a unit that will provide the most efficient heat at the lowest cost. And you get it...

WHEN you want it...

Specialists, devoted exclusively to the manufacture of electric heating units, Watlow can give you prompt, dependable delivery.

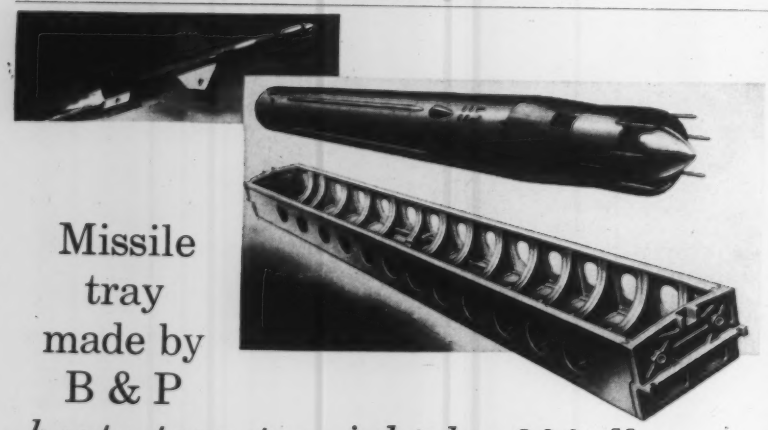
REMEMBER: if we don't have the unit you need, we'll *make* it!

write for WATLOW catalog

WATLOW

ELECTRIC MANUFACTURING CO.
1384 Ferguson Avenue
Saint Louis 14, Missouri

Circle 523 on Page 19



Missile tray made by B & P

beats target weight by 300 lbs.

Air transported missiles require minimum weight handling equipment so that important defense weapons can be moved efficiently and on schedule. Recently, Brooks & Perkins was given the responsibility for engineering, designing, building the prototype and manufacturing an aluminum missile tray, shown above.

Unusual loading problems and the extreme importance of deflection required a dimensional tolerance of ± 1/32" in the 33-foot over-all length at 68°F. B & P not only met all tolerance requirements, but also reduced the initial target weight by 300 lbs.

The aluminum missile tray is another example of Brooks & Perkins skill and experience in the fabrication of light metal products for ground support equipment.

For more information and details of this and other GSE programs, write direct to Brooks & Perkins, Detroit.

BROOKS & PERKINS, Inc.
1940 W. FORT ST., DETROIT 16, MICH.
Offices in Washington and New York

60-T-7

Circle 524 on Page 19

HELPFUL LITERATURE

Swivel Casters

Series L900 swivel plate casters, described in Bulletin 1259, are usable on trucks and portable equipment carrying loads up to 2000 lb. They are offered with 5, 6, and 8-in. sizes, and in a range of hard and soft tread wheels. Companion rigid plate casters are also detailed. 2 pages. Faultless Caster Corp., Evansville 7, Ind. J

Circle 712 on Page 19

Air Line Lubricators

Micro-Mist automatic lubricators for use in air lines feeding pneumatic equipment are available in 1/4, 3/8, and 1/2-in. line sizes with compressed air handling capacities of 5, 100, and 200 cfm. Full details are given in Circular 1015. 2 pages. Wilkerson Corp., 1601 W. Girard, Englewood 8, Colo. K

Circle 713 on Page 19

Hydraulic Controls

Selector, poppet relief, shut-off, and shear seal hydraulic valves as well as hydraulic system components for aircraft and missile use are subject of illustrated bulletin. They conform to MIL specifications. 4 pages. Telecomputing Corp., Whittaker Controls Div., 915 N. Citrus Ave., Los Angeles 38, Calif. L

Circle 714 on Page 19

Centrifugal Blowers

Bulletin 5812 gives design and performance data on the new No. 89C21 centrifugal blower for electronic equipment cooling applications. It delivers up to 105 cfm at zero static pressure. 2 pages. American Radiator & Standard Sanitary Corp., American-Standard Industrial Div., Detroit 32, Mich. H

Circle 715 on Page 19

Submersible Motors

Integral submersible motors ranging in capacities up to 40 hp for 4 to 6-in. diameter minimum well sizes are described in Bulletin P86023. Single and three phase types are available for standard voltages. Design features are shown with cutaway view. 4 pages. Franklin Electric Co., Bluffton, Ind. J

Circle 716 on Page 19

Electrical Connectors

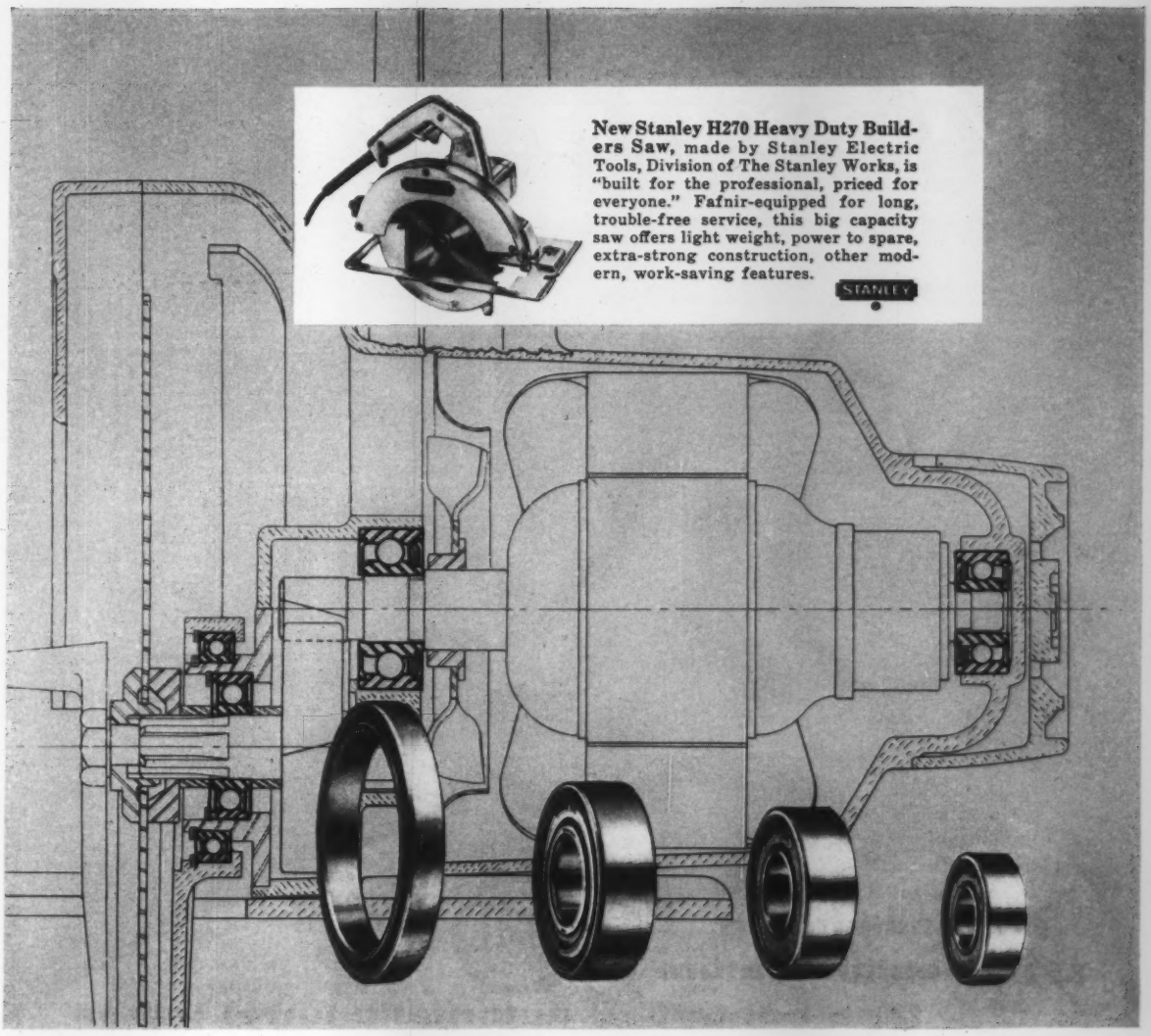
A buyers and engineers' guide to the selection of Amphenol AN/MS connectors illustrates units with from 1 to 52 contacts. A quick-reference specifications table is provided. 4 pages. Schweber Electronics, 60 Herricks Rd., Minneola, L. I, N. Y. C

Circle 717 on Page 19

Steel Tubing

Application of Smoothweld steel tubing systems to replace screwed or welding piping is discussed in technical bulletin. Tubing is soldered or silver brazed without the need of separate couplings. 4 pages. Standard Tube Co., 24400 Plymouth Rd., Detroit 39, Mich. H

Circle 718 on Page 19



New Stanley H270 Heavy Duty Builders Saw, made by Stanley Electric Tools, Division of The Stanley Works, is "built for the professional, priced for everyone." Fafnir-equipped for long, trouble-free service, this big capacity saw offers light weight, power to spare, extra-strong construction, other modern, work-saving features.

STANLEY

New Stanley power saw, Fafnir ball bearing equipped, designed to deliver nearly 40% more cutting force!

Armature, saw shaft, even the blade guard Fafnir-mounted for free-starting, no-maintenance, heavy-duty performance

Nearly 40% more cutting force at working speeds, with 27% less operator effort! This new Stanley power saw represents a design achievement of the first order. And to insure long, efficient service life, Stanley makes generous use of Fafnir precision ball bearings. Even the blade guard is Fafnir-equipped (with an aircraft type bearing), for responsive action at the slightest pressure. On the armature and saw shaft, Fafnir ball bearings all but eliminate friction and wear. Bearing maintenance is eliminated, too. Various combinations of seals and shields lock out contaminants, lock in factory-packed lubricant. No danger of faulty or neglected lubrication... virtually no chance of bearing failure.

Take advantage of Fafnir's "designer's approach" to bearing problems. You'll find Fafnir's breadth of experience and diversity of line insure precise answers. Write The Fafnir Bearing Company, New Britain, Connecticut.

Sealed and shielded Fafnir ball bearings meet specific service requirements in Stanley saws

Felt seal and shield (Motor Armature)

2 Plya-Seals (Blade Guard)

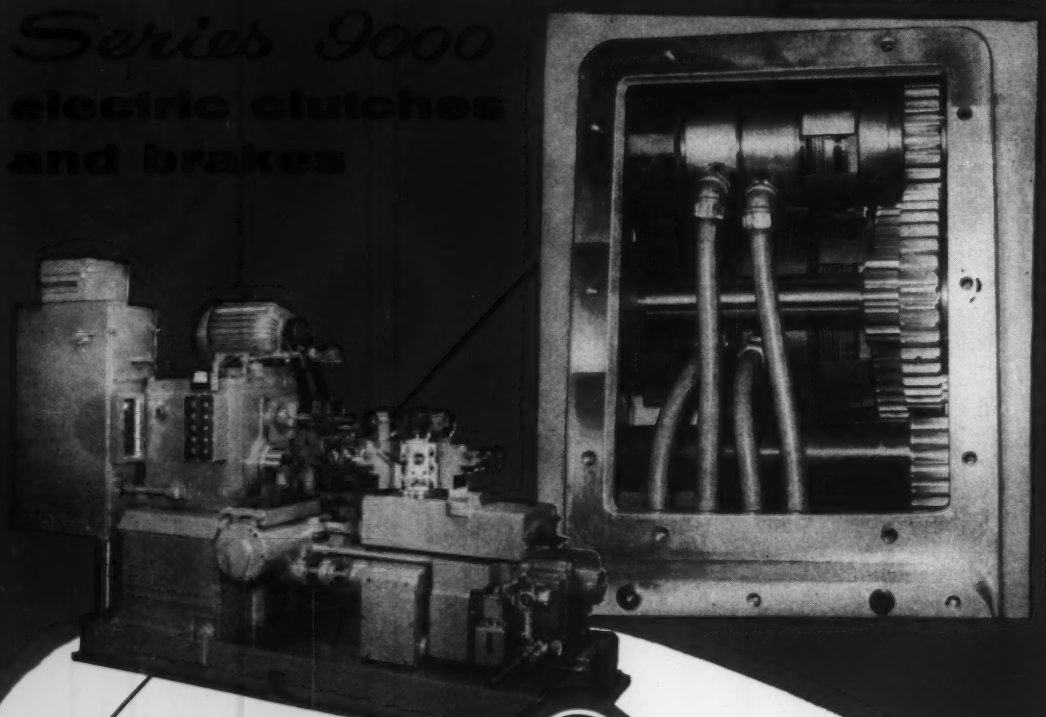
Plya-Seal and shield (Saw Shaft)

FAFNIR BALL BEARINGS

Circle 525 on Page 19

Maxitorq

Series 9000 electric clutches and brakes



an outstanding design feature of tape-controlled automatic turret lathes

Five Maxitorq Series 9000 Electric Clutches are used in the all-new Potter & Johnston No. 3E-15 Tape-Controlled Automatic Turret Lathe. Four are used in the headstock to provide automatic spindle speed changes and a fifth is used as a master clutch in the feed drive. These clutches of advanced design have PROVED their ability to assure consistent, positive and extremely fast action; essential to these machines. They transmit full load, are self-compensating for wear and permit great flexibility in control.

With operation induced entirely by magnetic flux, Maxitorq Series 9000 Electric Clutches are well adapted to a wide range of machine tool drives. They are simple and rugged in design, require no adjustments, can be used *either as a clutch or brake* and are built to American Machine Tool Standards. Disc separators not only separate discs, providing a drag-free neutral without heating, but also break up residual magnetism and permit extremely fast, positive action.

The 9000 Series Clutches have a minimum of moving parts and the electrical operating unit remains stationary, hence, there are no brushes, slip rings or complex wiring. Maxitorq Clutches operate on 110 V. A. C. rectified to 90 V. D. C. Other voltages on special order.

If you have a clutch or brake application where you are looking for new and improved performance, bring your problem to us.

Phone, wire or write Dept. MD for Series 9000 Bulletin.

The Carlyle Johnson Machine Company, Manchester, Conn.

3CJ59

Circle 526 on Page 19

Heavy Duty Casters

Series H900 heavy-duty swivel-plate casters are featured in Form 13059. They have load capacities up to 1500 lb per caster and are made in 6 and 8-in. diameter wheels. 2 pages. Faultless Caster Corp., Dept. PR-88, Evansville 7, Ind. J

Circle 719 on Page 19

Tungsten Carbide

Grades K601 and K701 platinum—bonded tungsten carbide are now offered to meet a broader range of industrial requirements for corrosion and wear resistant parts. Data sheet describes and lists properties of these new grades as well as the established Grade K501. 2 pages. Kennamental Inc., Latrobe, Pa. G

Circle 720 on Page 19

Precision Balls

"Balls Unlimited" is title of Bulletin BU-1 which presents line of OEM precision balls. Featured are standard balls of tungsten carbide, synthetic sapphire, nylon, and M-10 high speed steel. Special material balls are listed. 8 pages. Industrial Tectonics, Inc., Box 606, Ann Arbor, Mich. H

Circle 721 on Page 19

Magnetic Rectifier Controls

Line of small, light magnetic rectifier controls for power and servo control applications are described in Bulletin MRC 658. Units are applicable in systems ranging in power from a few watts to many kilowatts. 8 pages. Fairfield Engineering Corp., 934 Hope St., Springdale, Conn. B

Circle 722 on Page 19

Fabricated Products

Condensed catalog entitled "Creative Material Fabrication" details a line of standard and special fabricated products. Covered are metallic and nonmetallic washers, gaskets, packings, stampings, die cut parts, shims, and spacers. 4 pages L. J. Barwood Mfg. Co., Everett 49, Mass. B

Circle 723 on Page 19

Universal Joints & Drives

Light, medium, and heavy-duty series universal joints and drives are described in separate bulletins contained in brochure. Joints are used on winches, hydraulic hoists, steering mechanisms, agricultural machinery, automotive and truck power take-offs, marine equipment, and agricultural machinery. 16 pages. Neapco Products, Inc., Pottstown, Pa. E

Circle 724 on Page 19

Variable Transformers

The 126-226 series of Powerstat variable transformers described in Bulletin P559 have up to 12.5 amp constant current rating and up to 18.0 amp constant impedance rating. Open, enclosed, fused, cord-plug, and enclosed terminal models are offered. 8 pages. Superior Electric Co., Bristol, Conn. B

Circle 725 on Page 19

These NEW Hoke Valves are leak-tight* FOR LIFE!

100 SERIES

General Purpose Valve for service to 10,000 psi

The O-ring stem seal design on this new, low-priced valve makes it permanently LEAK-TIGHT*. Use the 100 Series where you need an inexpensive, heavy duty valve for either pneumatic or hydraulic service. It's ideal for throttling, regulating, or shut-off applications over a temperature range of –40° to 200° F. Male or female connection and panel mounting, if needed.

- GUARANTEED leak-proof O-ring seal
- Exclusive nylon stem wiper
- Centerless ground stem
- Safe, integral bonnet
- Diecast aluminum handwheel
- Rugged, forged carbon steel body in globe or angle pattern

300 SERIES

Forged Needle Valve with Plastic Stem Tip

The same unique stem design used on the 100 Series, plus a new plastic stem tip, makes Hoke's 300 Series valve LEAK-TIGHT* for life at both stem and seat. Made of long wearing nylon or corrosion-resistant Kel-F, these plastic stem tips have taken twice the normal closing force through 700 cycles of operation at 3500 psi – with no sign of leakage across the seat! Available in brass or stainless steel bodies, for service to 3000 psi. Panel mounting, too.

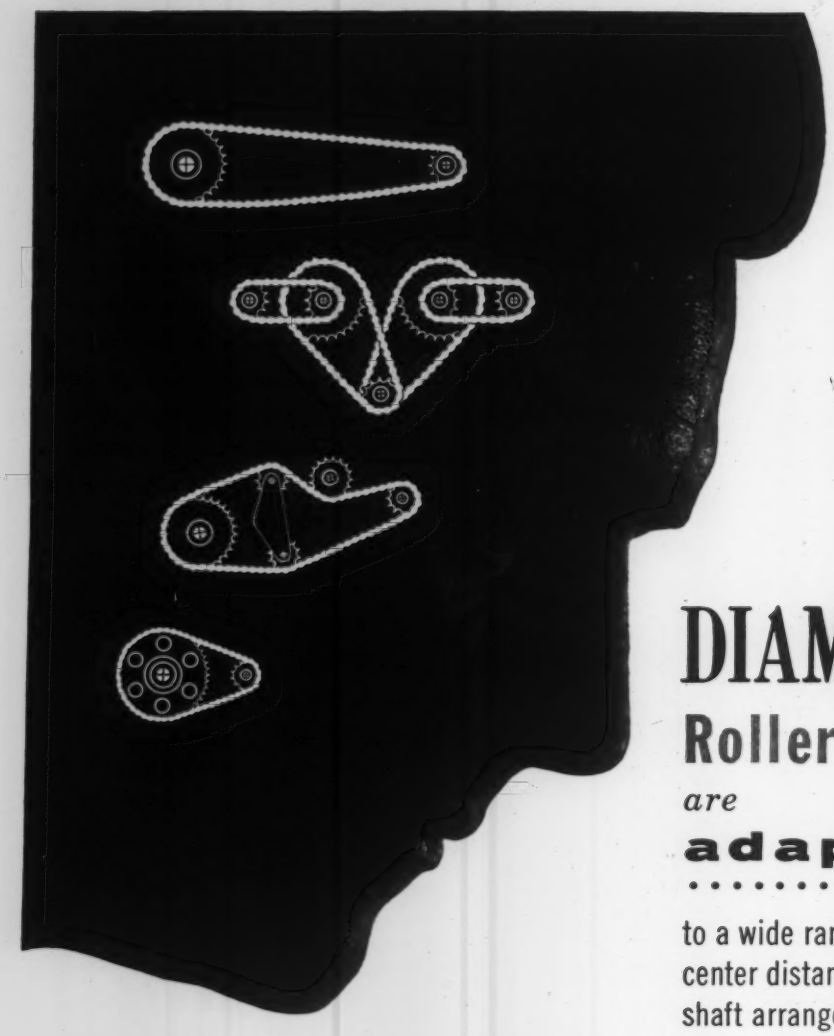
- Minimizes seat and stem point damage due to grit and over-torquing
- Provides vapor or vacuum leak-tight closure
- Minimizes opening pressure surges
- Service up to 3000 psi
- In ⅛" and ¼" pipe sizes and ¼" tube size

These are just two products in Hoke's extensive line of small, quality valves. If you would like our new Catalog GC959, or sample valves, write to us on your company letterhead.

HOKE

HOKE INCORPORATED
"Fluid Control Specialists"
91 PIERMONT RD., CRESSKILL, NEW JERSEY

Circle 527 on Page 19



DIAMOND
Roller Chains
are
adaptable

to a wide range of
center distances and multiple
shaft arrangements

DIAMOND Roller Chains are readily adjustable to long or short center distances. A number of shafts may be engaged and rotated in either direction at various speeds . . . all from a common drive shaft. Changing sprockets easily changes speed ratios.

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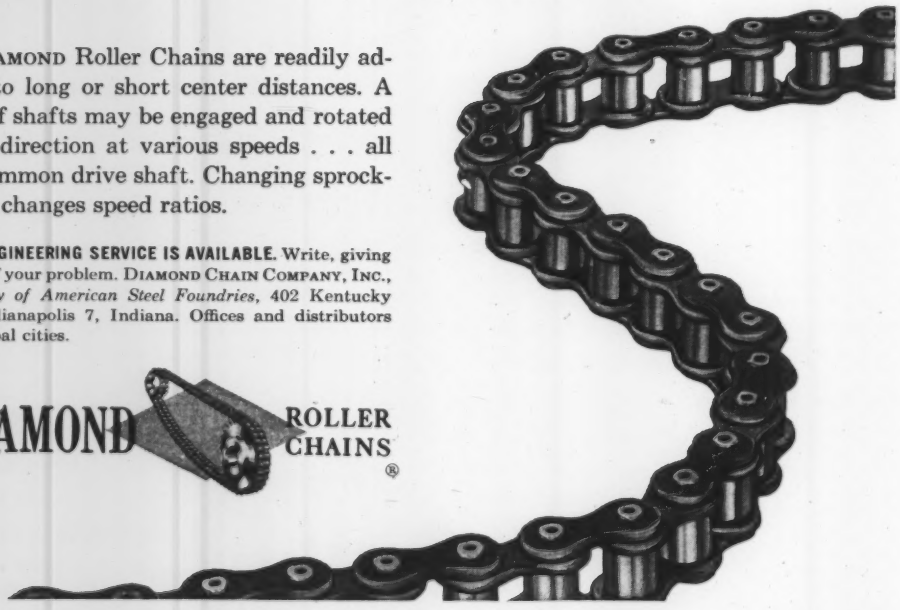
DIAMOND ROLLER CHAINS ®



Rotary Multipole Switches

Fast, accurate single-knob control of complex switching circuits is given by Esco rotary multipole switches described in Catalog 101-A. Switches are offered in electrical ratings from 5 to 200 amp. Features, dimensions, and mounting styles are also covered. 20 pages. Electro Switch Corp., Weymouth 88, Mass. B

Circle 726 on Page 19

Piping Practice Chart

Suitable for posting on shop bulletin boards, 17 x 22-in. wall chart on "Recommended Piping Practice" covers basic valve types, connections normally used, maintenance tools, installation, and operation and maintenance. Complete line of valves is illustrated. Lunkenheimer Co., Cincinnati, Ohio. G

Circle 727 on Page 19

Self-Locking Fasteners

Universal, one-piece self-locking fasteners that eliminate need for brackets and clips are subject of illustrated product catalog. Fasteners are used typically to mount heat ducts, wire bundles, and overhead panels. Nylon FLIP grommets for holding fuel cell bladders in aircraft, guiding control cables, and for use as contact insulators between metal surfaces are also covered. 20 pages. Western Sky Industries, 21301 Cloud Way, Hayward, Calif. M

Circle 728 on Page 19

Tool Steel

Characteristics, uses and machinability, forging, annealing, stress relieving, hardening, grinding, and sub-zero treatment are among subjects covered in booklet on Tri-Tung high-carbon, high-chrome, air and oil-hardening tool steel. It manifests minimum distortion with air hardening. 12 pages. Uddeholm Co. of America, 155 E. 44th St., New York 17, N. Y. D

Circle 729 on Page 19

Metal Powders

Prealloyed metal powders and tool steels used in powder metal parts production are discussed in Pamphlet 5 459 G. Metal powders are available in almost any analysis up to melting point of 3000° F. 8 pages. Vanadium-Alloys Steel Co., Latrobe, Pa. F

Circle 730 on Page 19

Gasket Design

The Armstrong "Gasket Design Manual" is a practical guide to solving problems encountered in the design of gasketed joints. It covers flange pressure, internal pressure, temperature, environment, flange surface conditions, stress-strain characteristics, sealing with confined resilient gaskets, and joint and gasket design. Supplementary folder describes Accopac fiber sheet gasket material. 34 pages. Armstrong Cork Co., Industrial Div., Lancaster, Pa E

Circle 731 on Page 19

design with IR compressors to assure Minimum Maintenance

One of the strongest sales points you can design into your air-operated equipment is the dependability and efficiency of the air supply.

Ingersoll-Rand air compressors are engineered with proven features that will give longer trouble-free operation—*reducing* costly maintenance and excessive downtime.

Bare, baseplate or receiver mounted air compressors can be supplied to meet your specific requirements.

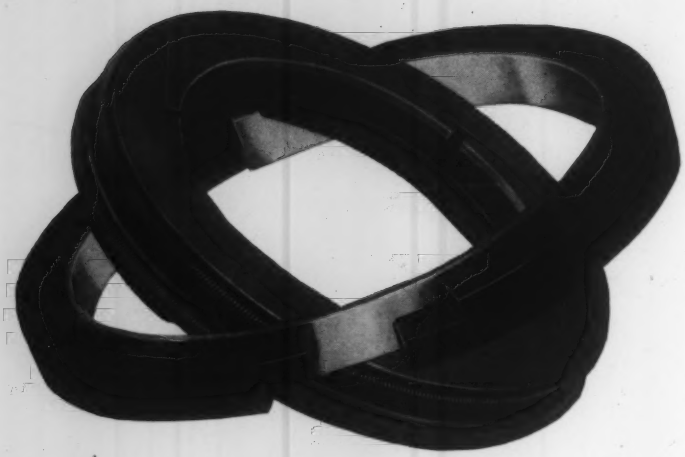
Ingersoll-Rand
11 Broadway, New York 4, N.Y.

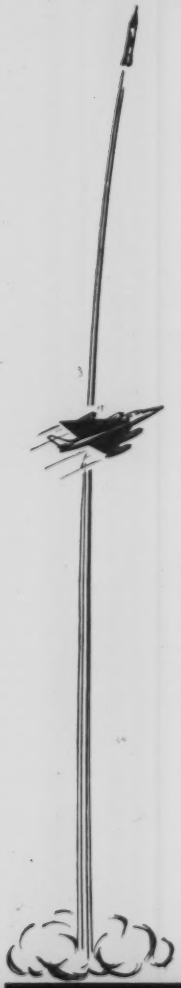
air-cooled compressors —½ through 20 horsepower

Other compressors to 6000 horsepower

3-675

Circle 529 on Page 19





FLUR-O-FRAN*

IT COSTS *LESS* TO GET *MORE* WHEN YOU BUY EXPERIENCE

Since 1947, when France first produced piston rings made from TEFLON† for hydraulic control cylinders, continuous research has kept France ahead in application engineering. It matters little whether your problem involves packing rings for a non-lube compressor, piston rings for compressor cylinders or piston rings for hydraulic applications. France can draw on vast experience with FLUR-O-FRAN in chemical, petrochemical, and in instrument air service, as well as the hydraulic field. Write today for full information.

* Trade Mark . . . FLUR-O-FRAN, a special compound of TEFLON and other materials, having unique properties—highly resistant to chemical attack—wide temperature range, −350°F to +500°F—extremely low coefficient of friction.

†Registered Trade Mark for du Pont FLUOROCARBON Resins

FRANCE PACKING COMPANY
9925 BUSTLETON AVENUE
PHILADELPHIA 15, PA.

Circle 530 on Page 19

HELPFUL LITERATURE

Time-Temperature Charts

Set of three conversion charts presents a convenient method of converting stress-rupture test data to a parameter. Data are measured in three variables: Time, temperature, and stress. Parameter value can be read directly from intersection of the time and temperature lines. Westinghouse Electric Corp., Westinghouse Aviation Gas Turbine Div., Dept. T-331, 95th & Troost Streets, Kansas City, Mo.

Circle 732 on Page 19

Valves & Fittings

Complete dimensional data and type drawings for all stainless steel taper seal valves and fittings for pressures to 15,000 psi are provided in Catalog 759. Standard connections data for 1/16 to ½-in. OD tubing are also included. 12 pages. High Pressure Equipment Co., 1222 Linden Ave., Erie, Pa. F

Circle 733 on Page 19

Rivetless Chain

Dimensional data relative to rivetless chain made from drop forged and cast manganese steels are furnished in Bulletin C-558. Chain is made in average ultimate strengths to 325,000 lb. 12 pages. Wilmot Engineering Co., White Haven, Pa. E

Circle 734 on Page 19

Hollow Shaft Motors

Design and construction details of drip-proof and weather protected units are given in Bulletin 212 on vertical hollow-shaft motors from 15 to 125 hp. Included is a graphic explanation of the non-reversing ratchet, self release, and rigid coupling. 4 pages Ideal Electric & Mfg. Co., Mansfield 82, Ohio. G

Circle 735 on Page 19

Electric Flowmeter

Control of catalyst carrier streams, additives, and chromatographic gas flow rates, and measurement and control of fuel flow rates are applications of the Model 59 electric flowmeter, subject of illustrated Bulletin 800. 2 pages. Thermal Instrument Co., Box 72, Cheltenham, Pa. E

Circle 736 on Page 19

Sampling Valve

Data Sheet 355 gives construction details, sizes, and ratings of Jerguson No. 23 drain or sampling valve which features a bolted bonnet for freezeproof action under all conditions. 2 pages. Jerguson Gage & Valve Co., 80 Adams St., Burlington, Mass. B

Circle 737 on Page 19

Electrical Connectors

Engineers are assisted in the selection of MS-E/R connectors by this guide to available insert arrangements and models. They meet MIL-C-5015C and MIL-C-5015D. 4 pages. Schweber Electronics, 60 Herricks Rd., Mineola, L. I., N. Y. D

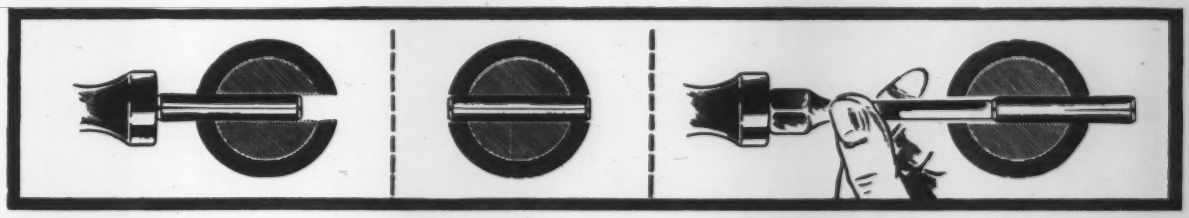
Circle 738 on Page 19

what makes this fastener DIFFERENT?

Several things. Rollpin® is a slotted, chamfered, cylindrical spring pin which drives easily into a hole drilled to normal production standards. It locks securely in place, yet can be drifted out and reused whenever necessary. This eliminates special machining, tapping, and the need for hole reaming or precision tolerances. Rollpin replaces taper pins, straight pins and set screws; for many applications it will serve as a rivet, dowel, hinge pin, cotter pin or stop pin.

And here's another difference that makes Rollpin the quality fastener in the field: ESNA's quality control builds consistent strength and performance into every Rollpin. Rollpin is uniform as to shear strength, dimensions, hardness, and insertion and removal forces.

HOW YOU INSERT IT



Drives easily by hammer, arbor press, or air cylinder and can be readily adapted to an automatic hopper feed. Requires only a standard hole, drilled to normal production-line tolerances.

Locks securely in place without using a secondary locking device; won't loosen despite impact loading, stress reversals, or severe vibration.

Removes readily with a drift pin without damage to pin or hole, can be used again and again in original hole.

HOW YOU SAVE

You pay less for Rollpins than for most tapered, notched, grooved or dowel pins. Installation costs are substantially less than for any fastener requiring a precision fit or secondary locking operations.

Because of their tubular shape, Rollpins are lighter than solid pins. Production maintenance is reduced with Rollpins: they do not loosen and because of their spring action they tend to conform to the drilled hole in which they're inserted, without material hole wear, eliminating the necessity of re-drilling or using oversize pins.

MATERIALS AND SIZES

Standard Rollpins are made from carbon steel and Type 420 corrosion resistant steel. They're also available in beryllium copper for applications requiring exceptional resistance to corrosive attack, good electrical, anti-magnetic, and non-sparking properties. Stock sizes range from .062" to .500" in carbon and stainless steels.

ROLLPIN®

ESNA

ELASTIC STOP NUT CORPORATION OF AMERICA

Dept. R40-114, 2330 Vauxhall Road, Union, N. J.

Please send me the following free fastening information:

☐ Rollpin Bulletin
☐ Elastic Stop nut Bulletin

☐ Here is a drawing of our product. What self-locking fastener would you suggest?

Name _____ Title _____

Firm _____

Street _____

City _____ Zone ____ State _____

Circle 531 on Page 19

50,000 HOURS

*of silent, synchronous power assembled in every **

HANSEN SYNCHRON® TIMING MOTOR

Manufacture of long-life, Hansen SYNCHRON Timing Motors is quality-controlled throughout, to make them the *best* synchronous motors for industrial and commercial applications. Skilled, experienced workers assemble Hansen SYNCHRON motors to rigid standards. Each motor undergoes 51 separate tests and inspections before shipment, insuring users of the ultimate in silent, continuous, synchronous power for specific timing applications.

Operating efficiently in any position, self-starting, self-lubricating Hansen SYNCHRON Timing Motors deliver from 8 to 30 in./oz. guaranteed torque; at temperatures from —40 F to +140 F; in speeds from 600 rpm down to ½ rph; clockwise or counterclockwise rotation. Over 200 types of output available.

The efforts of Hansen engineers have been concentrated in just one area for over 50 years — creating and applying synchronous power units to timing applications. Use this experience to solve your specific timing problems. Contact your nearest Hansen representative, or write direct.

HANSEN REPRESENTATIVES:

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5150 W. Madison, Chicago, Illinois

H. C. JOHNSON AGENCIES, INC.
Rochester, N. Y. • Buffalo, N. Y.
Syracuse, N. Y. • Binghamton, N. Y.
Schenectady, N. Y.

ELECTRIC MOTOR ENGINEERING, INC.
Los Angeles, Calif. (OLive 1-3220)
Oakland, Calif.

WINSLOW ELECTRIC CO.
New York, N. Y. • Chester, Conn.
Philadelphia, Penn. • Cleveland, Ohio

*An average figure for Hansen SYNCHRON Motors . . . many are designed for shorter life — others for years longer.

HELPFUL LITERATURE

High Pressure Pumps

At 800 psi, inside packed Triplex pumps will handle hot and cold water, brines, light oils, and abrasive solutions at output rate of up to 60 gpm. Specifications, features, and dimensions for these heavy-duty units are presented in Folder L-1166-A. 4 pages. Food Machinery & Chemical Corp., John Bean Div., Lansing 4, Mich. H

Circle 739 on Page 19

Generator & Control Systems

Ultra-fast response to speed and load fluctuations is feature of 5 to 50-kw, 125 v dc marine generator and control equipment described in Form 104. Detailed schematic and diagrammatic illustrations, plus time-response curves plotted from oscilloscope traces, are presented in detail 8 pages. Safety Electrical Corp., 1187 Dixwell Ave., New Haven 14, Conn. B

Circle 740 on Page 19

Standoff Insulators

Molded from glass fiber reinforced polyester, the Glastic line of standoff and center-post insulators is suitable for 600 to 5000-v use. Heights range from 1⅜ through 3½ in. Engineering dimensions, physical and electrical properties, and prices are provided in folder. 4 pages. Glastic Corp., 4321 Glenridge Rd., Cleveland 21, Ohio. G

Circle 741 on Page 19

Voltmeter-Power Supply

Direct currents from 1 to 501 v are measured with 0.02-per cent accuracy by the Model 301 combination voltmeter and powder supply. Described in Bulletin 15-7, it also supplies voltages in the same range at current levels to 20 ma. 2 pages. Cohu Electronics, Inc., Kin Tel Div., 5725 Kearny Villa Rd., San Diego 12, Calif. L

Circle 742 on Page 19

Rigid Polyethylene

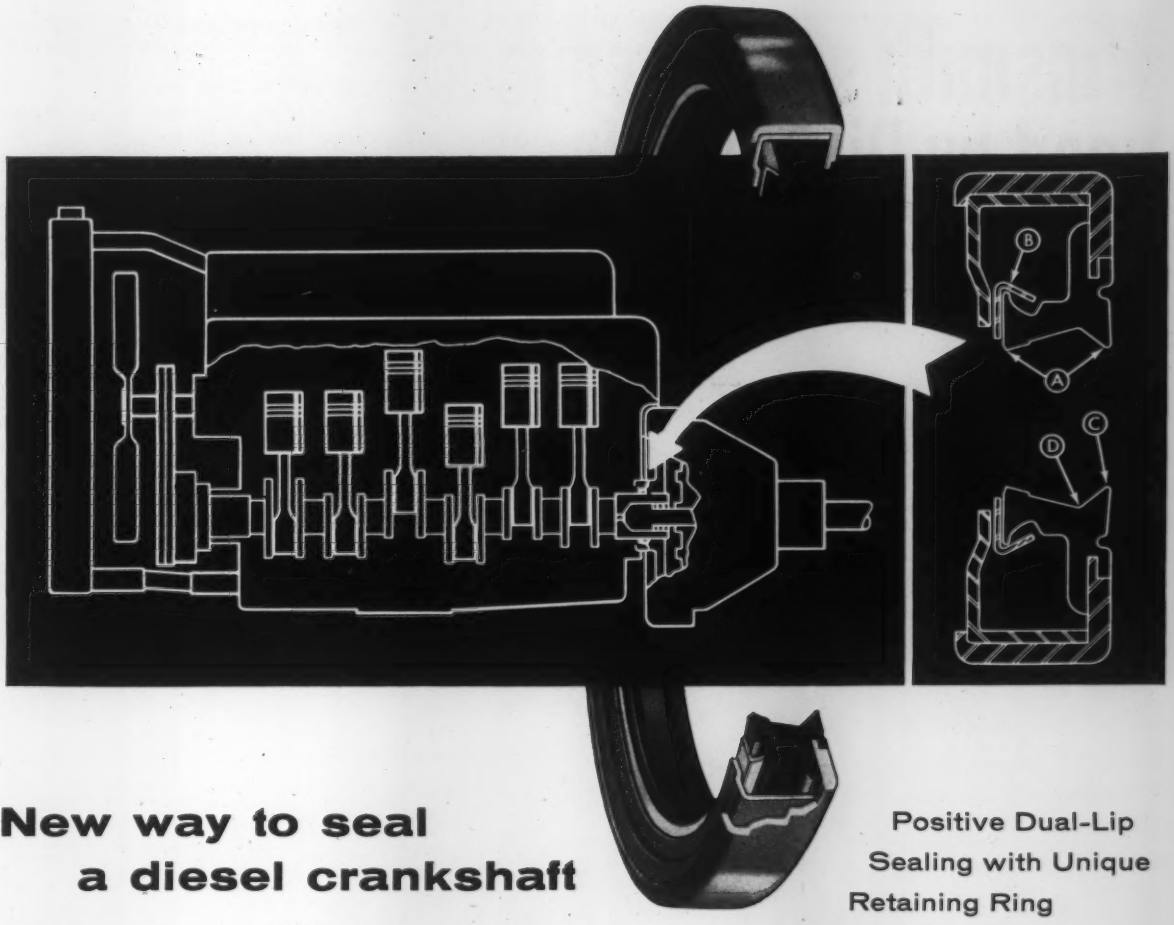
Brochure entitled "Marlex, Its Growth —Your Opportunity" illustrates applications and characteristics of Phillips olefin polymers. Some of the over 400 Marlex items now in existence since the rigid polyethylene was introduced three years ago are discussed. Properties include rigidity, high impact strength, high tensile strength, and low brittle point. 26 pages, plus two technical bulletins of 4 and 20 pages. Phillips Chemical Co., Bartlesville, Okla. P

Circle 743 on Page 19

Indicator Lights

Two-terminal subminiature indicator lights which mount from the front of a panel in a 15/32-in. hole are subject of illustrated Bulletin L-162. Four types covered are neon, incandescent, water-tight, and edge lighting. Features and specifications are given. 4 pages. Dialight Corp., 60 Stewart Ave., Brooklyn 37, N. Y. D

Circle 744 on Page 19



New way to seal a diesel crankshaft

Positive Dual-Lip Sealing with Unique Retaining Ring

The tremendous work loads being put on heavy-duty diesels call for a new look at sealing specifications. Stresses on the crankshaft often cause eccentricity with runout as much as .042 in. This makes holding a tight seal at the shaft rear extension with a standard seal design extremely difficult if not impossible. Another consideration is high working temperature—up to 300 deg. F.

Newest provision for this condition on a typical diesel is shown here. This unique yet simple modification of standard Victor oil seal design maintains positive mating of shaft and sealing element under any shaft divergence. The element—a silicone elastomer compounded by Victor—is good to 400 deg. F. intermittently.

In place of the usual garter spring, Victor engineers designed a unique retaining ring, loosely mounted over the sealing lip surface. The ring retains proper lip pressure while it permits the sealing element to follow the exact eccentricities of the shaft.

Have you a shaft sealing problem—or any problem involving oil seals or gaskets? Victor can help you solve it most economically. Contact your Victor Field Engineer or the factory. Victor Mfg. & Gasket Co., P.O. Box 1333, Chicago 90, Ill. Canadian Plant: St. Thomas, Ont.

A Basic design is Victor Type K6 with dual-lip standard construction. Provides maximum fluid retention and exclusion of foreign matter. Sealing element is silicone rubber, integrally molded and bonded to steel case.

B Metal retaining ring loosely mounted over the lip replaces usual garter spring. Allows expansion of element when seal is installed on shaft, yet confines element and retains even lip pressure in operation.

C Outer or secondary lip is molded with very little interference, avoiding danger of turning back lip on installation. When shaft enters primary lip, interference of secondary lip is increased through lever action.

D Lubricant applied between lips before installation permanently lubricates the seal, reduces frictional drag, extends seal life.

VICTOR

Sealing Products Exclusively

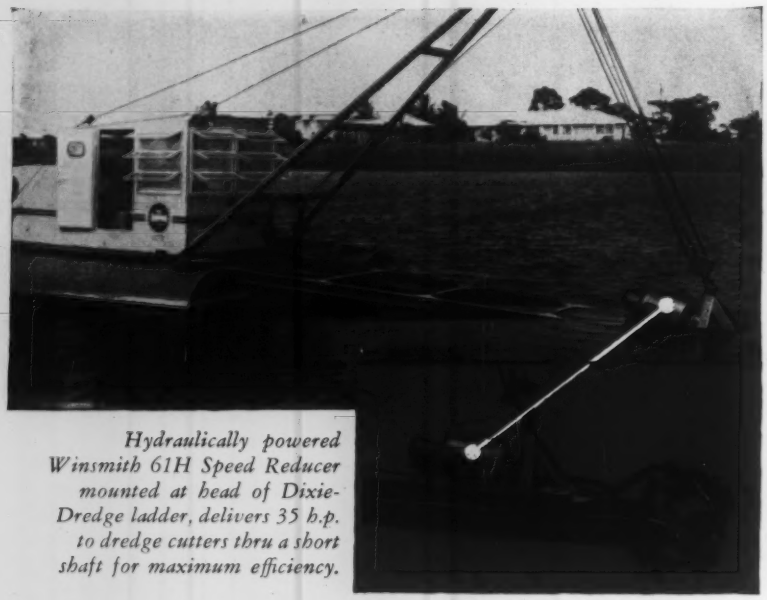
A complete reference manual for designers—Victor Oil Seal Engineering Catalog No. 305. Sent on request.

GASKETS • OIL SEALS • PACKINGS • MECHANICAL SEALS

Circle 533 on Page 19

Winsmith speed reducers used by Dixie-Dredge

in "one of the toughest jobs ever applied!"



Hydraulically powered Winsmith 61H Speed Reducer mounted at head of Dixie-Dredge ladder, delivers 35 h.p. to dredge cutters thru a short shaft for maximum efficiency.

"Winsmith Speed Reducers driving Dixie-Dredge cutters have a high shock load application and probably perform one of the toughest jobs ever applied," reports John H. Milne, president of Service Machinery Corp., North Miami, Florida, makers of this highly efficient, self-contained mobile dredging unit.

"Winsmith Reducers offer us a high torque output in a small package," says Mr. Milne. *"It operates at all angles from vertical to horizontal and has been very satisfactory in use."*

If you want satisfaction such as Service Machinery and leaders in every other industry are enjoying, check these Winsmith advantages: (1) most complete selection for every output requirement from 1/100 h.p. to 85 h.p. in ratios from 1.1:1 through 50,000:1, (2) shaft and mounting arrangements to fit your installation, (3) maximum torque designed into minimum space, (4) sound engineering and craftsmanship backed by over fifty years in the business. Write today for Catalogs 155 and SM-57. Select the "custom" reducer for your job from Winsmith Standard stock!

WINSMITH SPEED REDUCERS

WINSMITH, INC.

16 Elton Street, Springville, (Erie County), N. Y.

HELPFUL LITERATURE

Casters & Wheels

Alathane polyurethane elastomer, a chemical and solvent resistant wheel tread material of high strength and resilience, is used on swivel, rigid, dual wheel, and special casters and wheels illustrated in Catalog 59-B. Sizes range from 6 to 12 in. 4 pages. Albion Industries, Inc., Albion, Mich. H

Circle 745 on Page 19

Molded Plastics

Custom plastic molding services of company are outlined in Catalog 01.000.3 which also describes the wide line of molded products. Items shown serve the appliance, auto, aircraft, industrial, and electrical fields. 4 pages. Richardson Co., 2750 Lake St., Melrose Park, Ill. J

Circle 746 on Page 19

Potentiometer

Resistance range of 10 to 100 K is available in Model 200 Trimpot potentiometer, subject of a data sheet. The 0.1-oz unit dissipates 0.25 w at 70° C and its operating temperature is −55 to 105° C. 2 pages. Bourns, Inc., Box 2112, Riverside, Calif. L

Circle 747 on Page 19

Protective Coatings

"How To Use HumiSeal Protective Surface Coatings in Electronic Applications" is title of booklet which includes charts and slide rule settings. Vacuum impregnation, spray coating and masking, silk screen coating, and roller coating are detailed. 20 pages. Columbia Technical Corp., 61-05 31st Ave., Woodside 77, N. Y. D

Circle 748 on Page 19

Alloy Tubing

"How To Cut Cost by Using Alloy Mechanical Tubing" is discussed in Folder TB-430. Initial cost, structural advantages of tubing, fabrication by machining, types of steel, and types of tubes are covered. 4 pages. Babcock & Wilcox Co., Tubular Products Div., Beaver Falls, Pa. C

Circle 749 on Page 19

Phenolics

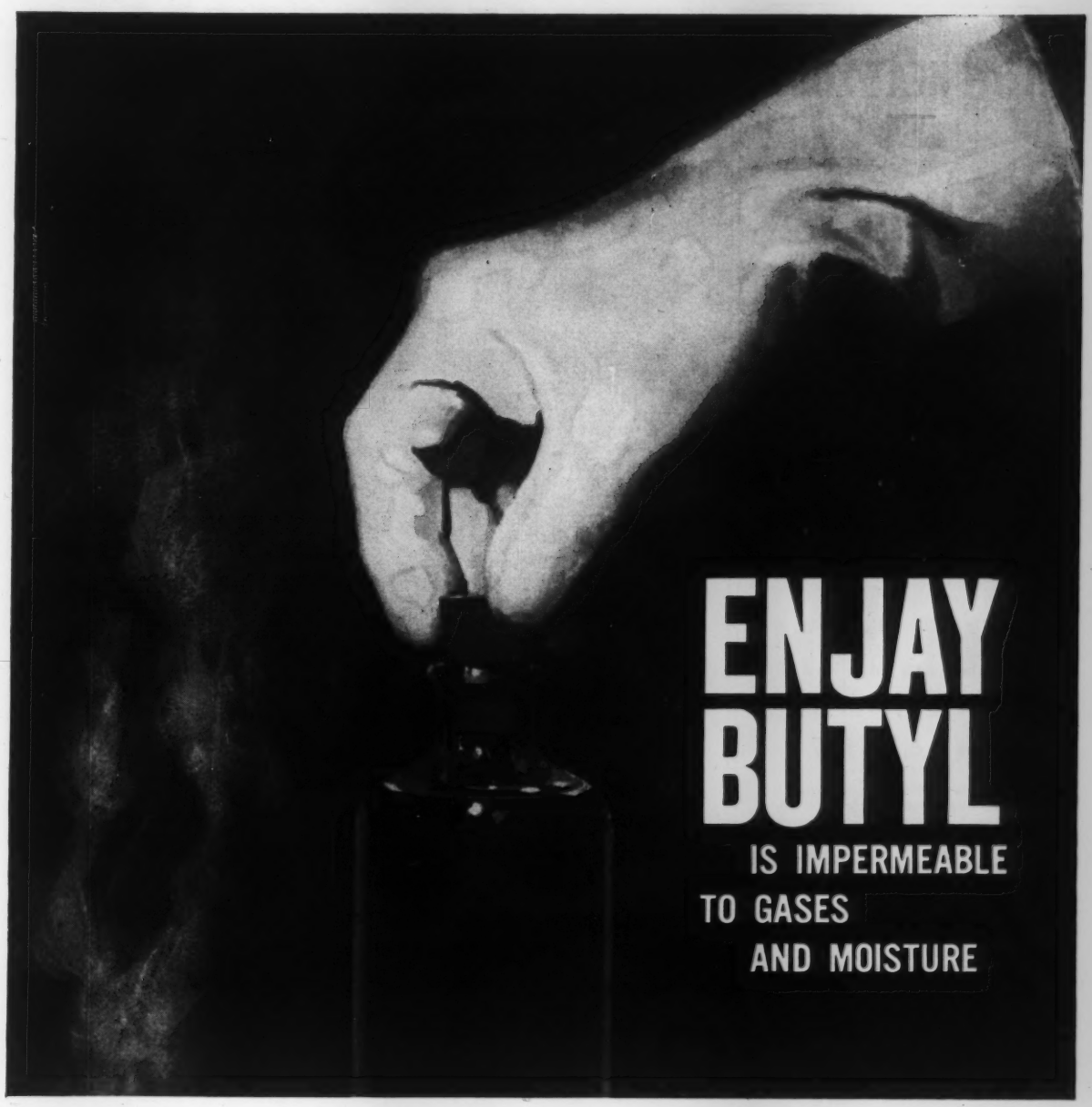
Physical properties of 33 Durez phenolic and three Durez diallyl phthalate molding compounds are listed in reference booklet, "Facts on Phenolics." Compounds in each group classification can be compared. 16 pages. Hooker Chemical Corp., Durez Plastics Div., Box 344, Niagara Falls, N. Y. N

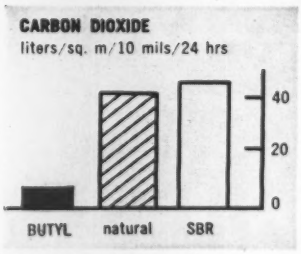
Circle 750 on Page 19

Thermostats

Stemco Type MX bimetal disc thermostats for electronic, avionic, and missile applications requiring narrow differentials and close temperature control are described in Bulletin 6100. Specifications of sealed and semi-enclosed types are given. 2 pages. Stevens Mfg. Co., Box 1007, Mansfield, Ohio. G

Circle 751 on Page 19





The impermeability of Butyl to carbon dioxide is demonstrated when compared with natural rubber and SBR.

Enjay Butyl rubber offers unmatched impermeability to gases, moisture and moisture vapor. Many applications prove Butyl retains air pressure 8 times better than natural rubber. Butyl outperforms natural and synthetic rubber in such applications as inner tubes, jar and bottle seals, inflatable sporting goods, window seals, hoses...wherever an impermeable barrier is required.

Butyl also offers outstanding resistance to sunlight and weathering . . . chemicals . . . heat . . . abrasion, tear and flexing . . . superior damping and unmatched electrical properties.

Find out how versatile, low-cost Butyl can improve your product. Call or write your nearest Enjay office.

ENJAY® BUTYL

EXCITING NEW PRODUCTS THROUGH PETRO-CHEMISTRY

ENJAY COMPANY, INC., *15 West 51st Street, New York 19, N.Y.*

Akron • Boston • Charlotte • Chicago • Detroit • Los Angeles • New Orleans • Tulsa

Circle 535 on Page 19

LOW HEAT LOSS
with

VULCAN
CARTRIDGE HEATERS

Vulcan Cartridges are one of the most efficient sources of electric heat because practically all heat developed passes to the part to be heated. In normal installations, the cartridge is completely surrounded by the metal or material to be heated.

Vulcan Cartridges are available in a wide choice of standard sizes — from 1" to 25" (or longer); diameter — ¼" to 1 19/64" (or greater); wattage — 10 to 3200 (or higher); voltage — standard 120 or 240, special 6 volts up; sheath — brass, steel, nickel or high temperature alloys; standard or special lead wires or terminals.

Send coupon for complete information.

VULCAN ELECTRIC COMPANY
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Cartridge • Strip • Tubular • Immersion Electric Heaters • Soldering and Branding Irons Solder and Glue Pots

VULCAN ELECTRIC COMPANY, Danvers, Mass.

Please send me catalog and prices on Vulcan Cartridge Heaters.

Name & Title.....

Company.....

Street & No.....

City & State.....

Circle 536 on Page 19

HELPFUL LITERATURE

Titanium Alloy

Physical, mechanical, and design properties of Ti-4Al-3Mo-1V heat treatable titanium alloy are presented in Engineering Bulletin 8. Its response to heat treatment and its fabrication characteristics are detailed, along with other technical information. 24 pages. Titanium Metals Corp. of America, 233 Broadway, New York 7, N. Y. D

Circle 752 on Page 19

Switching Transistors

Line of NPN transistors for high speed switching and high frequency amplification comprises 25 computer types for logic-circuit, core-driver, and other applications. Design features and specifications are detailed in six sections of Bulletin E-353. 20 pages. Columbia Broadcasting System, Inc., CBS Electronics Div., 900 Chelmsford St., Lowell, Mass. B

Circle 753 on Page 19

Plastic-Metal Screw

High torque and shear strength, and shock absorbing, vibration resisting, and insulating properties are claimed for the Insul-Screw, a plastic screw with a metal core. Subject of an illustrated bulletin, it is offered in several types in a range of sizes. Application data are included in the bulletin. 4 pages. Austin Screw Products Co., 4873 W. Armitage Ave., Chicago 39, Ill. J

Circle 754 on Page 19

Small Basic Switches

Type V3 postage stamp-sized switches, Type TB two-circuit switches, Type 1SX1 sub-subminiature switches, and Type SM subminiature switches are four Micro Switch groups covered in detail in illustrated Catalog 63. Design aids of the compact snap-action switches are included. Minneapolis-Honeywell Regulator Co., Freeport, Ill. K

Circle 755 on Page 19

Lead Wire Insulation

How silicone rubber offers long service life by maintaining its insulating properties on lead wire for prolonged operating periods and over a wide temperature range is related in Bulletin CDS-179. Silicone, polyvinyl chloride, neoprene, and natural rubber are compared. 4 pages. General Electric Co., Silicone Products Dept., Waterford, N. Y. C

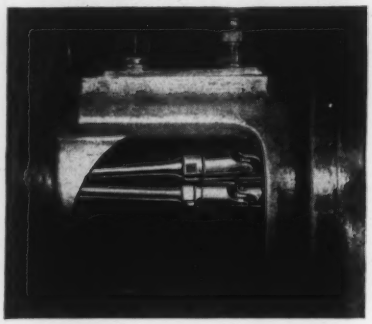
Circle 756 on Page 19

Finishing Processes

Various types of finishing and abrading processes such as grinding, deburring, descaling, and polishing are outlined in detail in illustrated brochure. How radii can be broken and fatigue resistance of metal parts strengthened is explained. Dimensions, capacities, and recommended usage of various types of equipment are included. A section is devoted to abrasive chips and compounds. 30 pages. Roto-Finish Co., 3700 Milham Rd., Kalamazoo, Mich. H

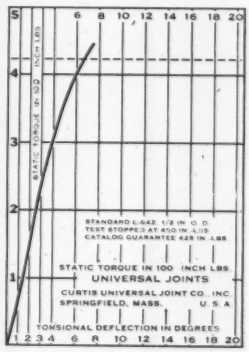
Circle 757 on Page 19

Solving a breakage problem AT CLOSE QUARTERS



The manufacturer of this button-drilling machine had a tough problem: the universal joints on these parallel shafts carried such a torque load there were frequent complaints of breakage . . . yet the close centers prohibited use of a larger joint.

THE SOLUTION was a Curtis Universal Joint of the same size.



Torque Curve ½" Curtis Universal Joint

This is only one of many problems solved by Curtis Joints — size for size the strongest universal joints designed for industry. Selected materials, precision engineering, and over 30 years' experience manufacturing universal joints make them that way.

14 SIZES ALWAYS IN STOCK —
3/8" to 4" O.D. (6" joints on special order)

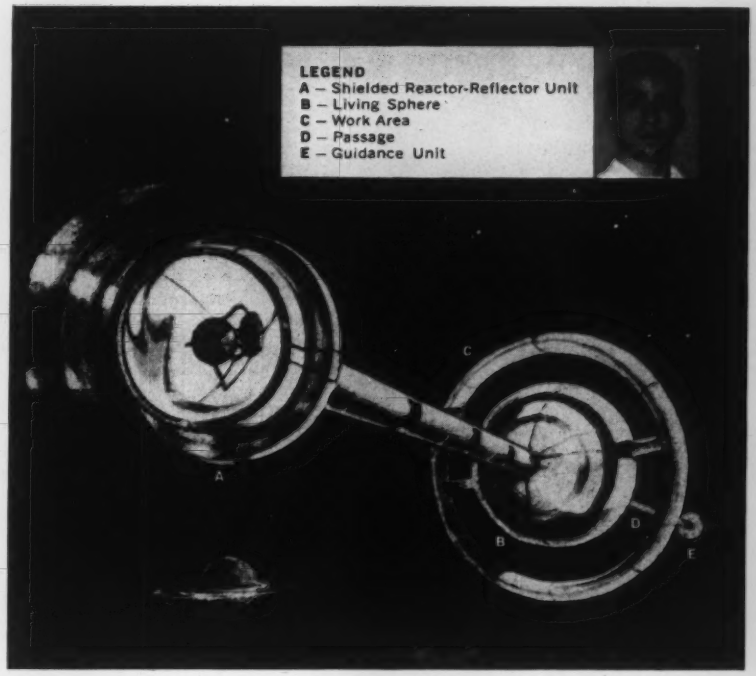
Not sold through distributors. Write direct for free engineering data and price list.

TRADE MARK CURTIS
UNIVERSAL JOINT CO., INC.
5 Birnie Avenue, Springfield, Mass.
As near to you as your telephone

EXCLUSIVELY A MANUFACTURER OF UNIVERSAL JOINTS SINCE 1919

Circle 537 on Page 19

No. 17 • Mars Outstanding Design Series



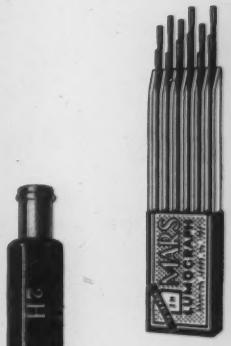
LIGHT TRAVEL – You may need to postpone your trip a half century or more but you will make up for lost time. So says Philip Schlesinger, of Buffalo, N. Y., who designed this light-powered space ship which will take you to distant space at almost the speed of light.

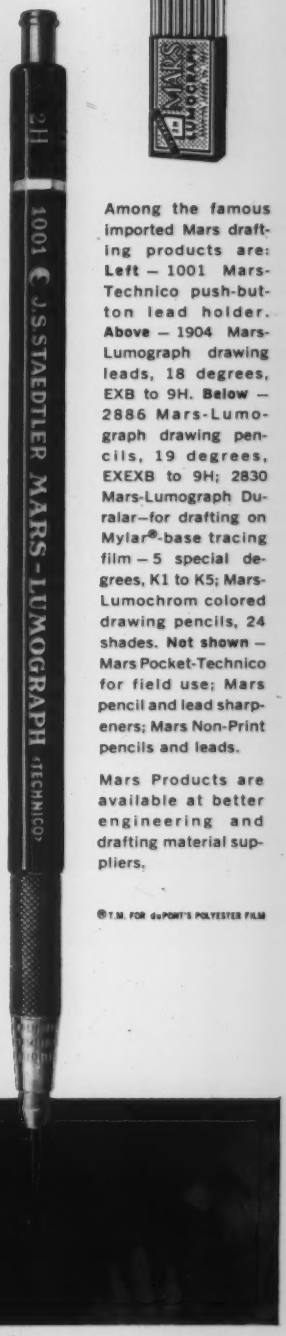
Based on Einstein's theory that matter can be converted into light, this Photon Powered ship derives its basic power from a small atomic reactor. The reactor is housed in a unit which also contains reflectors. Comparable to fluorescent screens, these convert the reactor heat, under great pressure, into light and thrust. The thrust is low, but extremely constant.

Launched disassembled inside a cargo rocket, the ship is assembled in space. It cannot land (a landing vehicle is provided for that purpose), but remains in orbit.

This is one more example of the creative contributions today's designers are making. To help them translate their pace-setting ideas from concept to reality, they require the best of drafting tools.

In pencils that means MARS, long the standard of professionals.

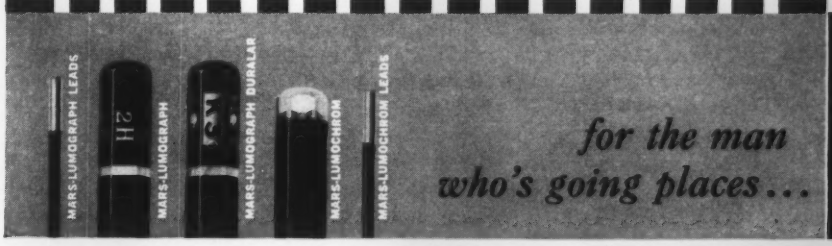




Among the famous imported Mars drafting products are: **Left** – 1001 Mars-Technico push-button lead holder. **Above** – 1904 Mars-Lumograph drawing leads, 18 degrees, EXB to 9H. **Below** – 2886 Mars-Lumograph drawing pencils, 19 degrees, EXEXB to 9H; 2830 Mars-Lumograph Duralar—for drafting on Mylar®-base tracing film – 5 special degrees, K1 to K5; Mars-Lumochrom colored drawing pencils, 24 shades. **Not shown** – Mars Pocket-Technico for field use; Mars pencil and lead sharpeners; Mars Non-Print pencils and leads.

Mars Products are available at better engineering and drafting material suppliers.

®T.M. FOR duPONT'S POLYESTER FILM



for the man who's going places...

the pencil that's as good as it looks **MARS**

Sold at all good engineering and drawing material suppliers • J. S. STAEDTLER, INC. • Hackensack, N. J.

Circle 538 on Page 19

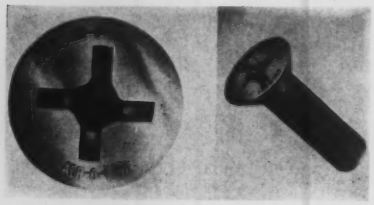
New Parts and Materials

Use Yellow Card, page 19, to obtain more information

Recess Fasteners

withstand high torque

Offset recess bolts, designated Aer-O-Torq, withstand up to 300 lb-in. torque per 1/4-28 thread using 160,000 to 180,000 psi heat-treated alloy steel. Developed especially for missile and aircraft applications requiring a high torque recess that would not cam out or ream out, units are also available as machine screws, bolts, or self-tapping screws for industrial and commercial use. Recesses are offset from one another, providing added metal build-up (shoulders) between each re-



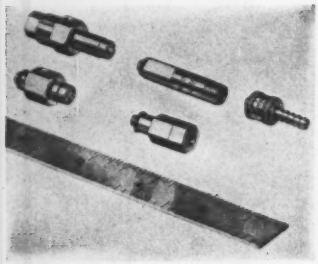
cess. Sizes available range from 2-56 to 1 in. diam, in all standard metals as well as A-286, Inconel X, and Titanium B120VCA. **Aer-O-Line Mfg. & Supply Co.**, 3110 Winona Ave., Burbank, Calif. L

Circle 758 on Page 19

Flow-Control Devices

miniature units are for air and oil

Minimatic air-oil flow-control units are useful in automatic and semi-automatic tooling, jigs, dies, fixtures, and new end products where savings in weight, space, and cost are required. Model MFC-1 flow control (upper left), 1 1/2 in. long, offers controlled flow in one direction and full flow in return direction at pressures from 0 to 250 psi. Air-flow rate at 50 psi is 0 to 3.6 cfm. Model MNV-1 needle valve (lower left) is 15/16 in. long and provides controlled flow in either direction at



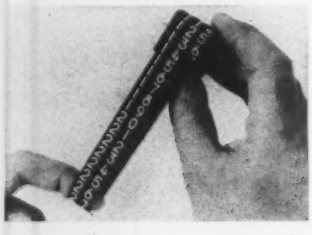
0 to 2000 psi. Air-flow rate at 50 psi is 0 to 2.6 cfm. MQC-V check unit and MQC-F hose connection (upper right) are 1 5/16 and 1 in. long, respectively. Recommended working pressure of the quick-connect units is 0 to 150 psi. Air-flow rate at 50 psi is 2.7 cfm. MCV-1 check valve (lower right), 1 in long, opens under 1 psi and holds 0 to 2000 psi. Air-flow rate at 50 psi is 3.5 cfm. **Clippard Instrument Laboratory Inc.**, 7390 Colerain Rd., Cincinnati 37, Ohio. G

Circle 759 on Page 19

Bearing Counter

is 360-deg tape-type unit

Bearing counter, useful in any application where an angular relationship to a reference line must be indicated, employs an endless tape for display of two left-hand digits. The 360-deg unit is approximately 1 1/16 in. long, 7/8 in. wide, and 1 3/32 in. high. Characters are 1/4 in. high, white on black. Tape is perforated to fit sprocket teeth on instrument drum, and can be led through vari-



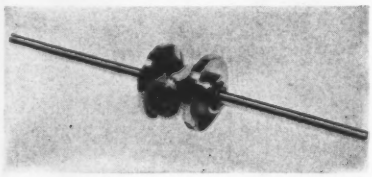
ous configurations or paths to fit most efficiently within an instrument and avoid internal components or other obstructions. Unit can be operated at 400 rpm constant speed or to 750 rpm intermittently. It meets all normal military performance and environmental requirements. **Veeder-Root Inc.**, Hartford 2, Conn. B

Circle 760 on Page 19

Miniature Differentials

in ball and oilless bearing units

V15 miniature precision differentials are available with shaft sizes of 5/64, 3/32, and 1/8 in. and use precision bevel gears. They are available in ball and oilless bearing units. Stainless-steel and aluminum end gears have 96, 120, and 200 pitches with teeth from 100 to 600. Static friction under load is not more than 5 per cent. Maximum recommended operation speed is 1000 rpm



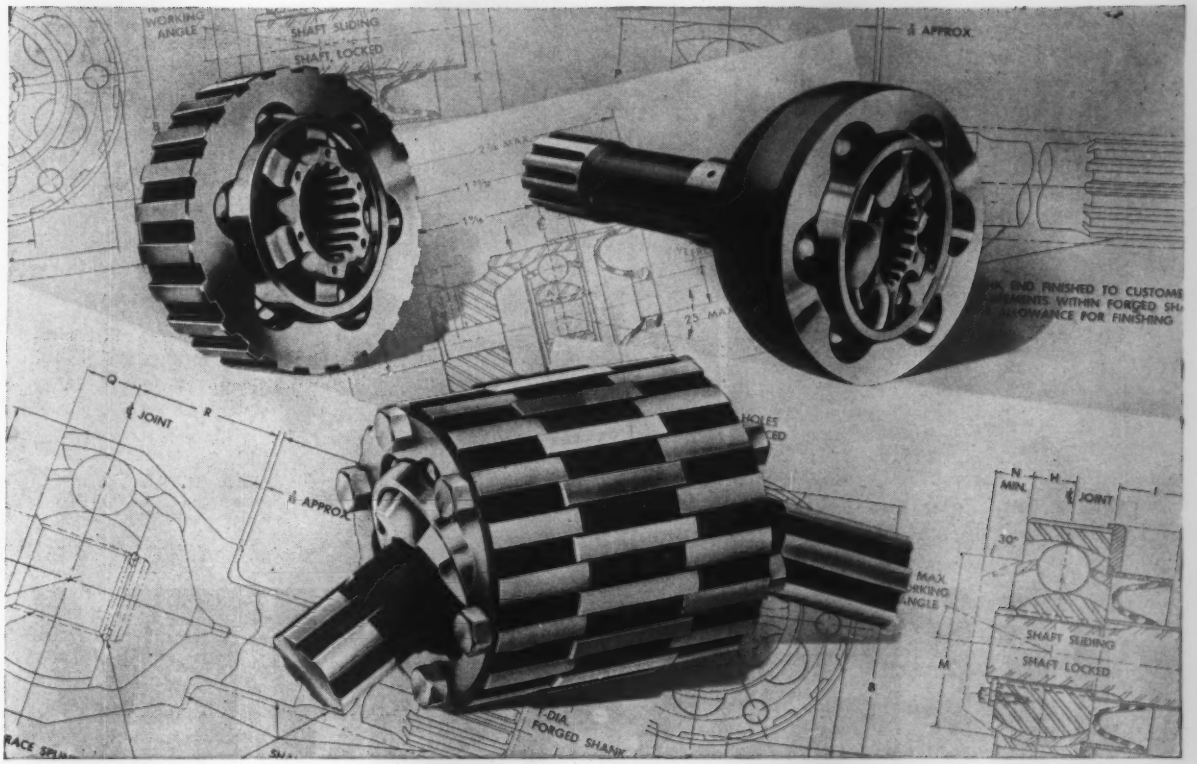
on ball-bearing units. **PIC Design Corp.**, 477 Atlantic Ave., East Rockaway, L. I., N. Y. D

Circle 761 on Page 19

Fractional-Horsepower Motor

has exposed laminations

Type AO fractional-horsepower, 4 1/8-in. diam motor is available in four and six-pole design in horsepower range from 1/8 through 1/50. The MicroMotor, with stamped steel case and exposed laminations, is suitable for many applications in the heating, air conditioning, ventilating, refrigeration, and appli-



RZEPPA UNIVERSAL JOINTS Now A Product Of DANA

New Con-Vel Division To Produce Famed Constant Velocity Universal Joints—With These Advantages To You:

- INCREASED SPEEDS
- REDUCED DOWN TIME
- LOWER MAINTENANCE COSTS
- HIGHER CAPACITY

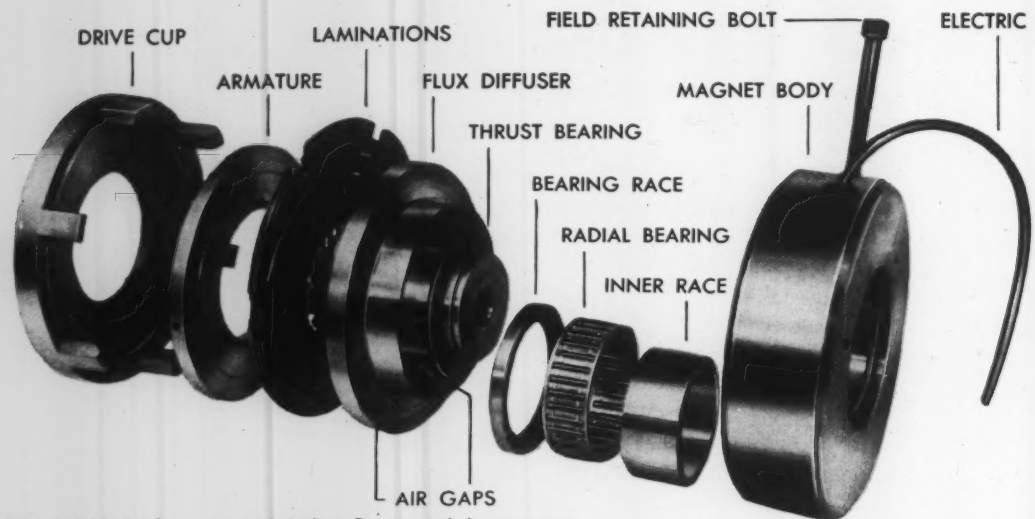
Rzeppa universal joints provide perfectly smooth torque all the time, every time, even at angles up to 35°! Rzeppa rules out bounce, chatter, vibration by keeping the hardened steel driving ball bearings in the correct bisecting plane, no matter what the shaft angle may be. The smoother, constant velocity performance of Rzeppa joints naturally increases shaft and bearing life; adds to over-all efficiency and economy of operation.

Rzeppa universal joints are available in a wide variety of sizes, angles, speeds and styles . . . designed for front drives, articulating axles, propeller shafts, and scores of special applications. For information on their many advantages write to—

DANA Con-vel

CON-VEL DIVISION
DANA CORPORATION
3901 CHRISTOPHER, DETROIT 11, MICHIGAN

Circle 539 on Page 19



Stationary field clutch . . . expanded view. See strength in every part. Roller-type thrust bearing packs enormous load-carrying capacity into small space. It is a type proved in automotive transmissions for years.

DURABILITY

The *durability* of I-T-E Electro-Clutches is one of the big reasons for making them your choice. Bearing life is equal to machine life. Each design of clutch is operated 100,000 times before torque rating is determined. After that, it is required to run several hundred thousand additional operations without loss of torque or need for maintenance of any kind. Nothing matches them.

FAST, FIRM CLUTCHING

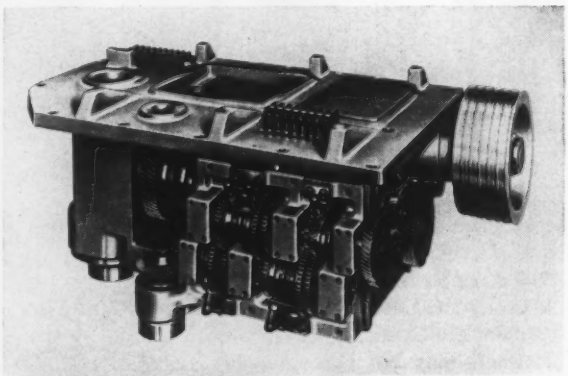
Clutching action takes place between interleaved laminations of *hardened steel* . . . not friction material or sintered nonferrous metals. The clutch lasts as long as the machine. No other clutch on the market offers such durability. In addition, because it has a fixed air gap, there are never any adjustments or loss of performance with age.

NEW MODEL NEVER NEEDS UPKEEP

Recently I-T-E introduced the *stationary field* Electro-Clutch that does away with the slipring and brush. So there is never anything to service. And never anything to replace. This means that designers can bury the clutch deep inside a drive box or transmission . . . for access is never needed. For easy assembly, they slide right on the shafts as one unit.

WIDE RANGE OF TYPES AND SIZES

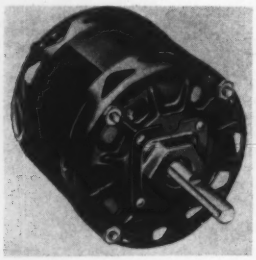
I-T-E Electro-Clutches are available to fit your own shafts and in torque ratings from 3.2 to 13,000 lb-ft. Stock voltage ratings are 24 and 90 v d-c. Other control voltages provided on request. Write for complete details. I-T-E Circuit Breaker Company, 1900 Hamilton St., Philadelphia 30, Pa.



They go inside with the gears and the oil. This is the main transmission of a Fosdick Precision Jig Borer. You can scarcely see the 13 standard I-T-E Electro-Clutches. But they are there . . . mounted right on the same shafts with the gears. Because they operate in an oily atmosphere, they save transmission space and simplify design.

I-T-E CIRCUIT BREAKER COMPANY

Circle 540 on Page 19



ance industries. It is available with internal fans, and is totally enclosed or open ventilated. **Redmond Co. Inc.**, Owosso, Mich. T

Circle 762 on Page 19

One-Part Epoxy Resin

is available in powder form

E-series powders are a specially formulated one-part, rigid epoxy resin in powder form. When applied by fluidized bed or spray coating and properly cured, they yield excellent coatings on a wide variety of substrates such as metals, glass, ceramics, and plastics. Powders have very long storage life and do not require refrigeration during storage. They are available in a wide range of colors. Films of cured resins have the following properties: Good electrical properties; good heat resistance; high heat-distortion temperature; built-in flow control; excellent oil and solvent resistance; low moisture absorption; good mechanical properties. Resin can be used as an insulating coating for many electrical applications. Other uses are as protective films against many solvents, corrosive liquids, and gases, and as decorative films for applications such as automotive and appliance parts. **Armstrong Products Co.**, Argonne Road, Warsaw, Ind. J

Circle 763 on Page 19

Wiring Raceways

include prefabricated corners and T-sections

Prefabricated corner and T-sections, designated Redi-Korners and Redi-Tees, in combination with straight Panel Chanel sections, form a modular, easily constructed system of raceways that eliminates bundling and lacing in panel wiring. Sections make mitering operations unneces-

"POP" RIVETS

How they work: "POP" Rivets are assembled on a precision-made high-tensile mandrel. Mandrel head is drawn into reverse side of rivet from the front with a setting tool. Mandrel head breaks off under tension clinching the rivet. Work is squeezed by compression-controlled radial expansion.

Permit use of thinner materials
Cannot strip and shake loose
Installed and set from the same side

Now you can easily and quickly fasten even .020 dead soft aluminum without distortion, fastener loosening, stripping, or surface marring. Also save over 50% on *installed* fastening costs.

No other fastener equals the speed and convenience of "POP" Rivets. Up to 1,000 an hour can be installed by unskilled help. They offer countless advantages in product design because they are installed and set from the same side. They need less than 1/16" clearance for back up space. Low head profile gives neater appearance without countersinking.

Investigate "POP" Rivets now for all kinds of sheet metal or plastic-to-metal fastening. "POP" Rivets are a new concept in fastening convenience for metal furniture, boats, trucks, trailers, appliances and houses, that justify your immediate investigation. Call or write us now.

Enamel Chipping Eliminated, tighter joints, increased production speed, no stripping even on 24 gauge steel, and small back-up space, helped Boston Stove Foundry Company engineer Magee Ranges with "POP" Rivets.

Convenience and speed reduce installation time on plastic or metal awnings, jalousies, gutters, downspouts, storm windows and doors, building skin and trim.

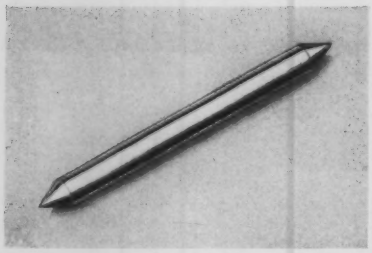
"POP" RIVET DIVISION
UNITED SHOE MACHINERY CORPORATION
SHELTON, CONN.
REgent 5-3391

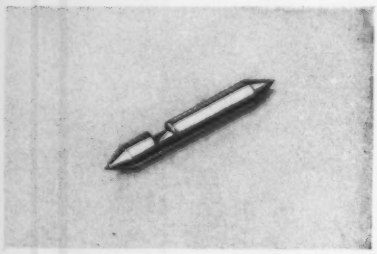
UNITED "POP" RIVETS

Circle 541 on Page 19

NEWS
from Torrington on
SMALL PRECISION METAL PARTS

"Custom manufacture" has many meanings to the Specialties engineers here at Torrington. One of our customers, for example, may require a part having fairly wide tolerances of several thousandths. The very next job on an engineer's desk may present a real challenge, calling for a complex series of manufacturing operations and a precision measured in ten-thousandths. Torrington's unmatched experience, engineering skills and facilities are ready to serve you *whatever* your particular requirements might be.





A comparatively simple job now going through calls for train axles for HO gage model equipment. The length tolerance is held to .010" and the diameter tolerance is .002". Our engineers complete the whole operation on super high-speed blanking machines designed by Torrington which operate at much greater speeds than available with other commercial equipment. Result . . . substantial savings on a low-cost, high-volume item for our customer.

In contrast to this, a current contract with one of America's leading clockmakers calls for a balance shaft with a diameter tolerance of .0005". If the shaft is supported at the points and rotated, the OD must rise and fall a maximum of .0015" during one revolution. Specialties engineers meet these more demanding specifications with a machine that will cut, form and mill in a single high-speed operation perfected by Torrington. Usual expensive burnishing is replaced by a much faster and far less expensive method to produce a fine finish. Result . . . another example of our ability to adopt new methods in solving a customer's problem economically.

A special engineering department is maintained by the Specialties Division to help you solve any problems involving small metal parts. If required, our highly experienced and skilled engineers will help you design the part for most efficient and economical production. More and more manufacturers are turning to specialized Torrington service. If small precision metal parts are *your* problem, just circle our number on the reply card, call our area salesman, or write direct to:

The Torrington Company, Specialties Division, 626 Field Street, Torrington, Conn.

TORRINGTON SPECIAL METAL PARTS

Makers of Torrington Needle Bearings

sary on corner sections and remove need to cut and fit T-connections. They are made with curved, smoothly formed inside surfaces to protect wiring. Notches in top of sidewalls are located to permit covers on two legs of a section to butt neatly together. Corners and T-sections are reinforced, thermosetting plastic that is strong, lightweight, and flame retardant. They are available in black, gray, or white in standard Panel Chanel sizes. **Stahlin Brothers Inc.**, 596 Maple St., Belding, Mich. T

Circle 764 on Page 19

Tubular Capacitor

is miniature, plastic-cased unit

Type P161N miniature plastic-cased paper tubular capacitor has excellent humidity resistance characteristics without necessity for over-all wax coating. Capacitors offer high insulation resistance and low power factor. Units are available in a wide

range of capacitances at voltages of 200, 400, 600, and 1000 v dc. Operating temperature range is −30 to +85 C. **Aerovox Corp.**, New Bedford, Mass. B

Circle 765 on Page 19

Clinch Nuts

miniature units have integral nylon cap

Type NKCFM clinch nuts are for use in a variety of miniaturized electronic components for aircraft, missiles, and electrically controlled and operated industrial equipment. Nuts incorporate a nylon cap which pro-

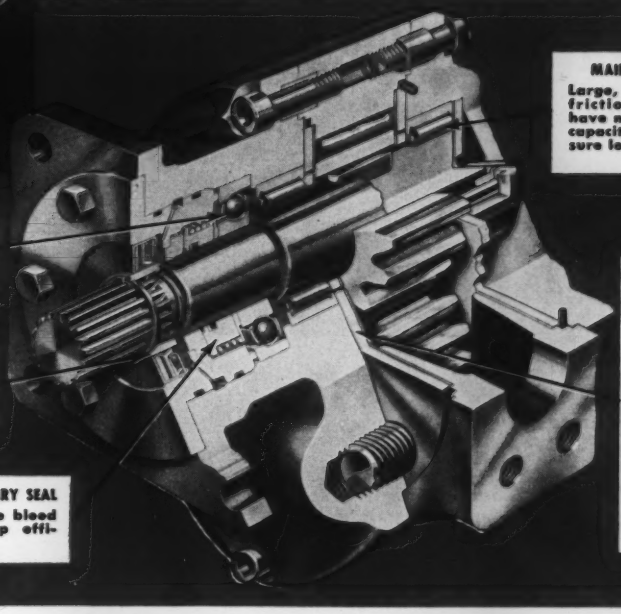
Circle 542 on Page 19

NOW • Added Service Life for the Accepted Leader Among Heavy Duty Fluid Power Pumps

1500 psi
57 to 97 gpm at 1800 rpm

HYDRECO®

Series 3000K FLUID POWER PUMPS



THRUST BEARINGS
Carry axial load of the drive shaft.

DOUBLE LIP SEAL
Protects high pressure seal and keeps dirt out of the pump.

HIGH PRESSURE ROTARY SEAL
Eliminates pressure bleed back, keeps pump efficiency high.

MAIN SHAFT BEARINGS
Large, heavy-duty, anti-friction roller bearings have more than adequate capacity to carry full pressure loads at high speeds.

PRESSURE-BALANCED WEAR PLATES
Balanced, hydraulic forces on both sides of the plates accurately maintain fixed clearances between the plates and the gear faces . . . high volumetric efficiencies are assured at all pressures and power-robbing, frictional contacts eliminated.

APPLICATIONS

EARTH MOVING EQUIPMENT
CONSTRUCTION MACHINERY
MATERIALS HANDLING EQUIPMENT
AGRICULTURAL MACHINERY
MOBILE and GENERAL
INDUSTRIAL EQUIPMENT

Member NFPA

The basic design of HYDRECO Fluid Power Pumps has been proven in thousands of successful installations . . . on Earth Moving, Materials Handling and Agricultural equipment . . . where dependability, efficiency and ruggedness are of prime consideration. *Now,* this famous design has been refined by improvements that give you this outstanding performance PLUS — *substantially extended service life — three times greater!* Translated in terms of dollars and cents, this greater service life adds value to the Pumps you buy and pays your customers extra dividends on their investment.

Check the features shown above . . . combined, they enable HYDRECO Series 3000K Pumps to set new standards in performance, efficiency and trouble-free service.

Write —

for performance and installation data on HYDRECO 3000K Series Fluid Power Pumps.

HYDRECO DIVISION
THE NEW YORK AIR BRAKE COMPANY
9006 EAST MICHIGAN • KALAMAZOO • MICH.

HYDRECO Division
The New York Air Brake Company
9006-11 E. Michigan
Kalamazoo, Mich.

Please send me complete information on HYDRECO Series 3000K Pumps.

Name _____

Company _____

Address _____

City _____ Zone ___ State _____

Circle 543 on Page 19

"Customeered" components basic to industry

ideas on "Customeered" RUBBER PARTS

...their design and application for improved product performance **No. 1**

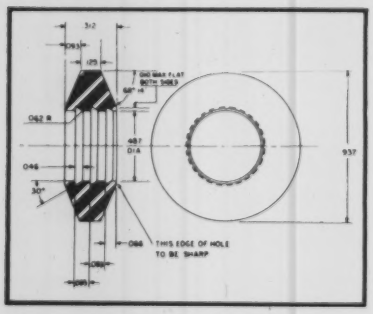
New ORCO continuous process now custom molds precision rubber parts in volume—at less cost!

Precise tolerances within ±0.003 in. are now possible in large volume production of custom-molded rubber component parts. Ohio Rubber's new high-speed, continuous molding process produces such parts at rates of up to 200,000 pieces per day.

Greater precision, which results in important savings on finishing costs, is assured through use of single-cavity, self-registering molds. They permit accurate, uniform application of pressure to minimize flash—maintain consistent tolerances for all dimensions. Uniform material thickness is equally assured by a plasticizing mill, which as an integrated part of the process directs uniform charges to each mold.

Direct feeding, from the mill to the mold wheel, eliminates the conventional intermediate extrusion step and further insures part uniformity and quality consistent with specifications. The continuous process permits *precise* control of time and temperature for each part.

Wide range of parts being more economically produced through Ohio Rubber's new molding process include (top, left to right): valve stem deflector, condenser seal, (bottom) seal piston rod packing, universal joint seal, and oil seal. These, like all the many other small, precision parts already produced or being produced, vary in dimensions up to 1½" in diameter and 1" in thickness.



High-precision is indicated in the close tolerances of this quadruple-landed seal for auto shock absorbers—more economically produced in volume through Ohio Rubber's new high-speed, continuous molding process.

Large volume production results in substantial cost savings for small, precision parts requiring tolerances obtainable by other precision molding processes. For parts formed by less precise, conventional methods, performance can be improved through greater accuracy—and without prohibitive increase in cost.

Quantity requirements involving 500,000 or more parts annually are recommended for most advantageous use of the new process. Since two similar parts of different size can be produced simultaneously by alternating the molds on the molding wheel, lower production runs which might not be economical can be combined with a separate order.

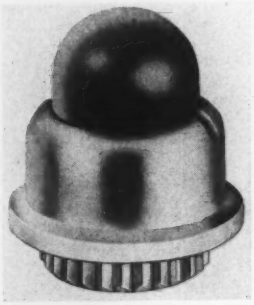
Complete information on this revolutionary new process is available in bulletin form. Send for your free copy today. At the same time, be sure to inquire about Ohio Rubber's complete component "Customeering" service—molding, extruding, and bonding-to-metal. Just mention ORCO Bulletin 715.

9DE1

THE OHIO RUBBER COMPANY
WILLOUGHBY, OHIO
A DIVISION OF THE EAGLE-PICHER COMPANY

Circle 544 on Page 19

tects bolt threads against corrosion, chafing of wires by exposed bolt ends, effectively limits corona and electrical discharge in high-voltage circuits, and seals internal or external pressures up to 80 psi past bolt threads. One-piece cap and locking element is heat-stabilized nylon which resists environmental temperatures to 350 F. Shank lengths of 0.04 and 0.06 in. are available in each thread size to insure adequate grip and flush mounting. Nuts are available in thread



sizes 4-40 through 10-32 and are steel, cadmium plated or stainless steel, plain finish. **Elastic Stop Nut Corp. of America**, 2330 Vauxhall Rd., Union, N. J. D

Circle 766 on Page 19

Laminated Plastics

for severe-service electrical insulation

Two general-purpose grades of Dilecto epoxy-impregnated, glass-base laminated plastics are designated GB-28EV-2 and GB-16EV-2. The latter is made from a finer weave cloth than the former, permitting its use in thinner laminates and for finer machining. Both materials are available as plain sheets or as Di-Clad, copper-clad sheets for printed-circuit applications. Laminates are designed for electrical-insulation applications requiring high reliability in severe service conditions. They offer low electrical loss properties, good arc resistance and dielectric strength, excellent tensile and impact strength, and good compressive strength. Both grades are designated NEMA G-10 laminates and meet requirements for MIL-P-18177B, Type GEE. Sheet sizes are 38 x 42 in. and 38 in. square. In thickness, GB-16EV-2 is available in 0.01 to 0.125 in., and GB-28EV-2 ranges

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BIJUR
AUTOMATIC LUBRICATORS

For DESIGN, SERVICE AND RESEARCH
are part of every Bijur System DSR

Consider Design — All Bijur pumps are designed to be an integral part of your equipment not a cumbersome attachment. Compact modern designs permit easy adaptation, enabling operation of the pump by means of gear, belt or chain drive or independently operated by electrical or hydraulic set-ups.

How you benefit — Custom-engineered Bijur automatic lubricating systems save production time and repair bills. Down-time and fire risks are sharply reduced. Costly hand oiling is eliminated and every bearing gets the right amount of oil when needed — there's no chance of under oiling or over oiling.

Day-in, day-out Bijur Systems are proving their value to designers, plant engineers and production men on the equipment they design, use, or manufacture. Write today for all the facts about Bijur automatic lubricating systems!

BIJUR AUTOMATIC LUBRICATORS—STANDARD EQUIPMENT IN MANY INDUSTRIES
Machine Tools • Business Machines • Printing Machinery • Textile Machinery • Food Product Machines • Bottling Machines • Packaging Machines • Sheet Metal Machines • Plastic Fabricating Machinery • Glass Products Machinery • Wood-Working Machinery • Industrial Sewing Machines • Special Process Equipment

BIJUR
LUBRICATING CORPORATION
Rochelle Park, New Jersey
Pioneers in Automatic Lubrication
4341

Circle 545 on Page 19

IT PAYS TO HAVE HUBBELL GOOD CONNECTIONS

Manufacturers of Cold Headed Fasteners Since 1888

OVER 5 TIMES THE RATE AT 45% LESS COST

Another example of how Hubbell Cold Heading produces Better Parts at Faster Speeds, at Lower Cost

THE PART:
Special 1-64 Miniature Binding Screw

THE MATERIAL:
18-8 High Tensile Stainless Steel

THE METHOD:
Hubbell Cold Heading in place of screw machining

THE RESULT:
a. Production increased from original rate of 7000 pc. p.d. to cold heading rate of 40,000 pc. p.d.
b. Cost reduced 45%
c. Finer Quality—More Economical Production
1. Higher Tensile Strength
2. Cleaner, Stronger Threads
3. No Scrap Waste
4. No Separation from Chips

Hubbell Cold Heading may provide equally dramatic results for you. Whether it is presently cold headed or not, send blueprint of part or sample for analysis and estimate.

HARVEY HUBBELL, Inc. Machine Screw Dept.
Bridgeport 2, Connecticut

Kindly estimate on the enclosed Sample (Blueprint). Quantity _____

Name _____
Title _____
Company _____
Address _____

Circle 546 on Page 19

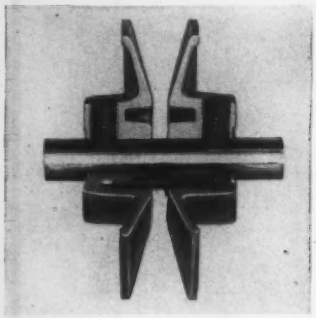
from 0.0312 to 1 in. The latter is also available as rolled tubing in sizes from 2 to 12¾ in. ID and 2½ to 13½ in. OD with minimum wall thickness of ¼ in. **Continental-Diamond Fibre Corp.**, Newark, Del. C

Circle 767 on Page 19

V-Belt Pulley

has variable pitch

V-belt pulley, with micrometer adjustment to set pitch to rpm desired on driven pulley, is a 3¼-in. diam unit. It can be used with ⅜, ½, and ⅝-in. top width V-belts. Each half of pulley is directly fastened to motor shaft, eliminating any par-



allel or angular misalignment between halves. Pulley is available in ½ to ⅝ in. bore sizes. **Congress Drives Div., Tann Corp.**, 3750 E. Outer Drive, Detroit 34, Mich. T

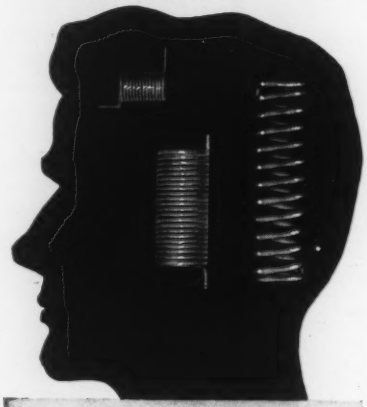
Circle 768 on Page 19

Solenoid Valves

are available in high-pressure types

Two-way Type R line of pilot-operated solenoid valves now includes high-pressure models in two-way, normally closed construction and in a wide range of voltages and frequencies with many electrical options. Orifice size is ¼ in. diam with ¼ in. NPTF ports. Operating pressure differentials are 5 to 1250 psi on ac input and 5 to 1000 psi on dc input, with higher than standard ratings available for specific applications. Valves are designed for use with air, oil, water, and other common media. High-pressure models are available in both standard and explosionproof construction. Spring-loaded plunger and piston assembly provides positive closing,

SPRINGS ON YOUR MIND?



• Your next thought should be of the Spring Engineers at John Chatillon & Sons. Send them your blueprints and specifications for study and recommendation.

• With more than 120 years of experience and knowledge at their command, they can provide you with the exact spring you require—on time, at competitive prices.

• Chatillon has the trust of the largest users of springs in the world because of the Chatillon reputation for filling orders that others would consider impossible.

• Next time, benefit by the thorough knowledge of Chatillon Spring Engineers. They'll be glad to help you. Send your blueprints to: Department D-2.

JOHN CHATILLON & SONS
85 CLIFF STREET, NEW YORK, N. Y.
Manufacturers of Precision Springs and Force Measuring Instruments Since 1835.

Circle 547 on Page 19

The New

interchangeable with all standard JIC cylinders

With the introduction of the ALL NEW T-J Squair Head, Tomkins-Johnson now offers industry the most complete design range of air and hydraulic cylinders. Presently available in bore diameters from 1½ to 8 inches, the T-J Squair Head is an interchangeable cylinder which produces maximum force and efficiency, with minimum pressures ... and is also adaptable to the use of low pressure oil as the working medium. Write to The Tomkins-Johnson Co., Jackson, Michigan, for Bulletin #SQ 10-58 and complete details.

CHECK THESE 10 POINTS OF T-J SUPERIORITY

1 One Piece Piston

2 Hard Chrome Cylinder Bore and Piston Rods

3 High Tensile Steel Tie-Rods

4 Cushion Adjusting Screw, Externally Adjustable

5 New Super-Cushion for air, or Self-Aligning Master Seal for Oil (T-J Patents)

6 Solid Steel Heads and Mounting Plates Standard all Models

7 Port Design Allows Minimum Pressure Drop on Inlet or Outlet

8 Chevron Type, Self-Adjusting Rod Packing

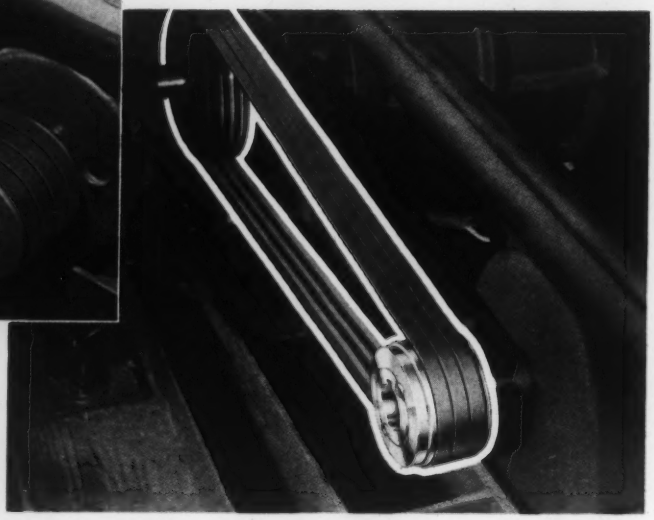
9 Piloted Packing Gland—Absolute Alignment

10 Piston Rod, Extra Strong—Polished and Chrome Plated for Efficiency and Protection

T-J TOMKINS-JOHNSON

Circle 548 on Page 19

Before: Four standard belts were required to drive the clothes pressing unit manufactured by a Utah company.



After: Three Gates Super HC V-Belts now handle the redesigned pressing unit drive — save more than 16 pounds in drive weight — 24% in drive cost.

Utah manufacturer cuts drive cost 24% with new high capacity V-Belt

Drive weight reduced 16 pounds per unit!

This manufacturer is just one of many who have already turned to Gates Super HC V-Belts to achieve far more compact, lighter weight, lower cost V-belt drives for all types of machines. With new Super HC V-Belts, sheave dimensions can be reduced 30% to 50%, overall space up to 50%, and drive weight by 20% and more.

A product of Specialized Research in the world's largest V-belt laboratories at Gates, the Super HC V-Belt Drive is already standard equipment on production models in virtually every industry.

Engineering Service Nation-Wide

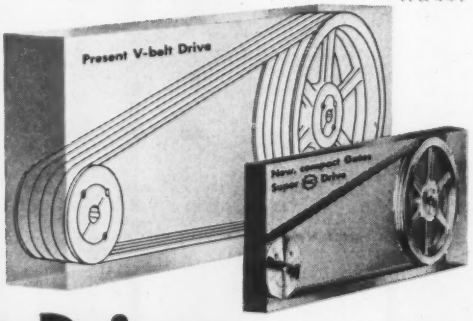
Whatever your plant's power transmission design problem, wherever you are, your nearby Gates Distributor or Field Representative is ready to assist you to cut space, weight, and costs with Super HC. Ask him for a copy of "*The Modern Way to Design Multiple V-Belt Drives.*"

TPA 447

The Gates Rubber Company, Denver, Colorado
Gates Rubber of Canada Ltd., Brantford, Ontario

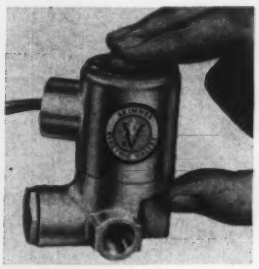
Gates

World's Largest Maker of V-Belts



Gates Super HC V-Belt Drives

same hp capacity in smaller "package"



permitting mounting in any position. **Skinner Electric Valve Div., Skinner Chuck Co.**, Dept. RR134, 105 Edgewood Ave., New Britain, Conn. B

Circle 769 on Page 19

Spray Coating

for high-impact styrene products

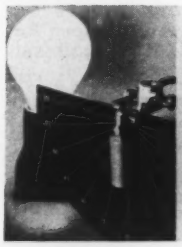
Rez-N-Lac C coating formulation provides fast, economical spray application of durable colors on products of high-impact styrene material, ABS plastics, and acrylics. End products include radio and television cabinets, automotive trim, and decorative components for household appliances. Spray produces a smooth, hard, high-gloss finish with firm adhesion that withstands severe pressure-sensitive tape and crosshatch scratch tests. **Schwartz Chemical Co. Inc.**, 50-01 Second St., Long Island City 1, N. Y. D

Circle 770 on Page 19

Safety Switch

has contacts which open when switch is tipped

Tip-off safety switch is for portable room heaters and other portable electrical appliances that are electrical or fire hazards when accidentally tipped over. Actuator of switch contacts is a pivoted, steel pendant that tends to maintain a vertical position at all times, re-



at your fingertips...

COMPLETE STOCKS OF NYLON, TEFLON*, KEL-F†

Whatever your needs may be, choose from complete and ample stocks of these materials . . . and enjoy fast delivery.

NYLON Rod and Tubing. Guaranteed bubble free, light weight CHEMISEAL Nylon has excellent mechanical properties, resistant to chemicals, oils, grease, solvents. Available in many diameters and lengths.

TEFLON Sheet, Tape, Rod, Tubing, Bars, Cylinders. Impervious to all chemicals except molten alkali, TEFLON is suitable for use at temperatures from −110° to +500° F. It's tough and abrasive resistant, has a low coefficient of friction, zero water absorption, excellent dielectric properties. Comes in widest variety of types and sizes.

KEL-F Sheet, Rod, Discs, Bars, Cylinders. Resists chemicals, alkalies, solvents. Offers high compressive strength, low cold-flow characteristics. All sizes on hand to meet your needs.

You'll get prompt service anytime, anywhere. Just call or write the nearest of the Garlock Packing Company's 26 sales offices and warehouses throughout the U.S. and Canada.

*DuPont Trademark for TFE Fluorocarbon Resin
†M. M. & M. Trademark

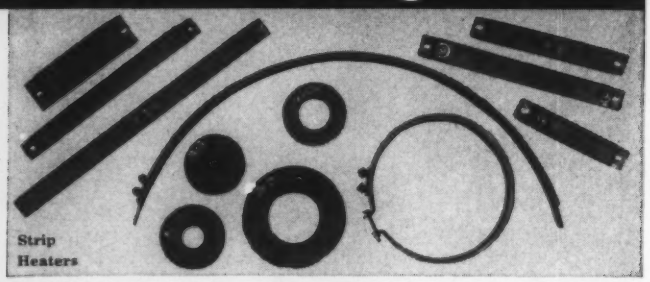
United States Gasket

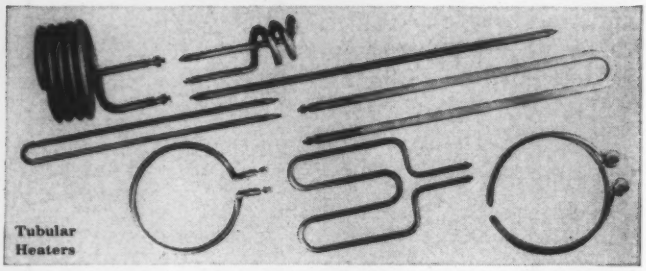
THE GARLOCK PACKING COMPANY, Palmyra, N. Y.

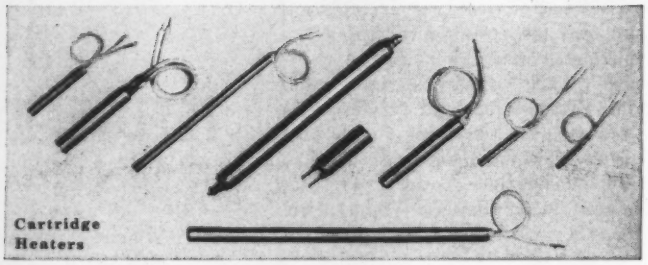
Plastics Division of GARLOCK

Circle 550 on Page 19

Call your CHROMALOX Man for the heating answers







These 3 basic CHROMALOX heaters provide answers to just about any heating problem

Strip Heaters . . . that quickly and easily bolt or clamp to platens, dies, kettles, tanks, pipes, rolls, drums, ovens and air ducts. Lengths from 4 to 96 inches, widths from ¾ to 2½ inches, with cross section curving or lengthwise bending. Available with brazed-on fins.

Tubular Heaters . . . that clamp on, fit into machined grooves, cast into metals, immerse in liquids, install in ovens and ducts. Straight lengths or factory-formed to nearly any contour. Lengths from 6 inches to 30 feet. Triangular or round cross section. Available with brazed-on fins.

Cartridge Heaters . . . that smoothly fit standard drilled holes in dies, platens, molds, extrusion and injection barrels. Special leads available for protection against flexing action, abrasion, moisture or vapors. Diameters from ⅜ to 1 19/64 inches, lengths from 1⅝ to 25⅜ inches.

Versatile Chromalox electric heaters are available in sheath materials and wattages to match almost any application to 1100°F. Easy to install, they are fast, clean, safe and economical.

Each has particular advantages. Your Chromalox Man can help you determine the one that best answers your specific problem. He's backed by the world's largest factory stock of industrial heaters, ready for immediate shipment. Why not give him a call. You'll find his phone number listed at the right.

Our new Catalog 60 provides detailed product information and suggests numerous applications for the complete line of Chromalox electric heaters for industry. If you have not yet received a copy, please let us know.

7780

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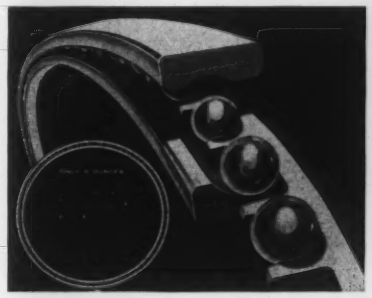
gardless of position of switch. When switch is tipped more than 45 deg from vertical, pendant still hangs vertically but switch contacts are opened (right). Switch uses stainless-steel contact springs with spot-welded silver contacts to assure long life. It is available with spade or screw-type terminals, and is rated at 15 amp, 118 v, or 8 amp, 236 v. **Bryant Electric Co.**, Bridgeport 2, Conn. B

Circle 771 on Page 19

Thin-Section Bearings

are lightweight units with 4 to 12-in. bores



Reali-Slim CP bearing line, now available from stock at reduced prices, includes 90 sizes with 4 to 12-in. bores. The lightweight bearings have Conrad deep-groove ball radial construction and one-piece bronze snap-over separator for improved bearing operation. Six series are furnished, with 15 sizes in each series. Sizes range from ¼ to 1-in. width and cross section. High-carbon chromium bearing steel, AISI E-52100, is used for bearing races, which are hardened to Rockwell C 58 to 62. **Kaydon Engineering Co.**, Muskegon, Mich. T

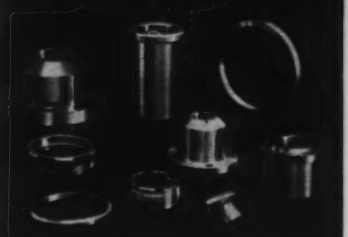
Circle 772 on Page 19

Motor-Generator Unit

miniature unit is for precision instrument use

RBG-2407 miniature motor-generator unit combines a low-inertia control motor with an ac drag-cup rate generator for precision instrument applications requiring a compact, commercially priced device. Rate generator has output of 10 v per 1000 rpm with linearity of about 1 per cent. In order to provide high rate of response, standard servo mo-

MANY WRONGS MAKE OUR SLEEVE BEARINGS JUST RIGHT



The scores of design errors we have encountered in 25 years of bronze bearing production comprise one of the most valuable benefits we can offer you — *experience*. The experience to help you with design problems, to suggest a slight change which will not affect performance but will save production costs, to use the correct alloy for optimum bearing life or to provide the proper lubrication system.

It is this experience that gives us the confidence to offer the largest variety of bronze bearings available anywhere . . . a full range of sizes in both cast and sintered bearings including grooved and graphited items.

Be sure to take advantage of this specialized knowledge the next time you have a bearing problem. Let us help you avoid the pitfalls of others. We will welcome your inquiries.

See the coupon below for some information you should have in your files.

A Founding Member—
Cast Bronze Bearing Institute

RENEWAL SERVICE INC.
1703 Lehigh Ave., Phila. 32, Pa.

Send me "Chemical and Physical Specifications of the Bronze Alloys" which includes MIL., SAE, Navy, Aero., ASTM, and Fed. Spec. Comparatives.

Name_____

Company_____

Address_____

Renewal Service INC.

Circle 552 on Page 19

GUARANTEED LAMINATED PLASTIC PARTS

ALL BY RICHARDSON

For many years The Richardson Company has served industry as a skilled fabricator of high quality, uniform laminated plastic parts . . . produced to exacting customer specifications.

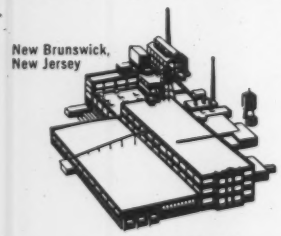
As the manufacturer of INSUROK® laminated sheets, tubes and rods, Richardson guarantees the finest fabricating materials in a wide range of NEMA, Federal and Special Grades.

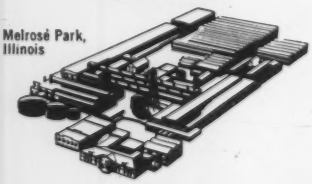
Fabrication dies and tools are designed and produced right in Richardson plants. Therefore, they are properly engineered for the material and will produce quality parts.

Two Richardson plants located in New Brunswick, New Jersey and Melrose Park, Illinois offer complete fabrication facilities for all forms of laminated plastics. This assures you prompt shipment of finished parts.

From ONE RELIABLE SOURCE you obtain quality materials, tooling, and fabricated parts.

To get more details on how Richardson's integrated fabrication facilities can serve you, write to The Richardson Company.





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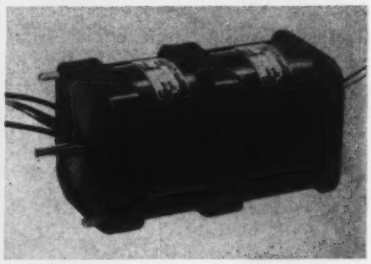
LAMINATED AND MOLDED PLASTICS — Founded 1858

DEPT. 42, 2795 LAKE ST. • MELROSE PARK, ILL. • SALES OFFICES IN PRINCIPAL CITIES



tor with high torque-to-inertia ratio is used. Motor gear ratios from 2.5:1 to 3600:1 are available. Standard control-winding impedance is 5400 ohms locked rotor, with other winding impedances available on request. All units are 2 17/32 in. square in cross section, and overall lengths are 4 1/8 in. for direct-drive motors and 5 in. for gear motors. **Holtzer-Cabot Motor Div., National Pneumatic Co. Inc.**, Boston, Mass. B

Circle 773 on Page 19

Roller Chain

has Delrin flat-top plates

Unisyn flat-top roller chain combines top plates of Delrin acetal resin with steel roller chain. It eliminates stretch of chain of any length and closes gap between plates to within 1/32 in. Delrin is lightweight, maintains a low coefficient of friction against extremes of heat, stress, and moisture, is im-

pervious to solvents, and has bacteria resistance equal to stainless steel and rubber. **Union Chain and Mfg. Co.**, Sandusky, Ohio. G

Circle 774 on Page 19

Vinyl-Plastic Fabric

deadens sound and vibration

Coustifab high-density, low-mass sound and vibration-attenuating material is a flexible, vinyl-plastic sheet impregnated with metallic lead powder and backed with either

NEW, COMPACT, HI-TORQUE
HI-RANGE REDUCTION DRIVES

IDEAL FOR APPLICATIONS NOT POSSIBLE WITH OTHER TYPES OF REDUCERS... AND FOR STANDARD REQUIREMENTS.

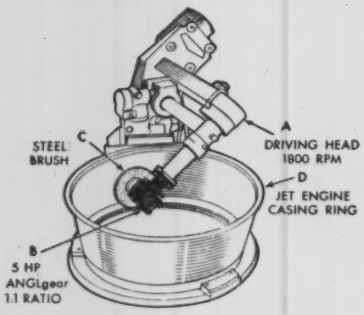
HI-RANGE Cycloid-Type Reduction Drives are 40% to 60% smaller than other types of reducers with comparable ratings. They provide a wider range of torque—and pound for pound, a higher torque—than any other type of reducer... ranging from about 30 in.-lb. torque per pound of reducer weight to over 80 in.-lb. torque per pound. As a result, HI-RANGE units lend themselves extremely well to special applications and integral design. They are ideal where space or weight or both are important factors and where, in addition, high torque is required.

Black Tool Engineers are highly experienced in the design of reducers for special applications. They will be glad to consult with you on your reduction drive problems.

Write today for Brochure RD-200.

BLACK TOOL, INC.
1924 South Navajo Street
Denver 23, Colorado

ANGLgear® simplifies power-brush drive

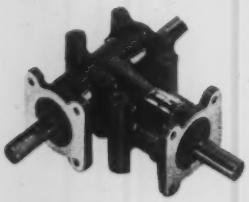


Drawing shows ANGLgear application on Osborn Brushamatic® unit developed for finishing jet engine case components. ANGLgear permits compact design, has capacity to withstand reversal every 20 sec. without overheating.

Osborn Manufacturing Co., a Cleveland, Ohio, producer of power-brush finishing machinery, has found ANGLgear ideal for adapting brushing heads to right-angle drive. Offering high capacity for its size, ANGLgear permits compact head design, facilitates brushing in restricted spaces. At the same time, its light weight cuts the overhung load to a minimum, helping reduce bearing wear. And it has the stamina to meet operating conditions that include reversal every 20 seconds —without overheating or undue wear.

Perhaps ANGLgear can solve a similar 90° drive problem for you. Completely enclosed, permanently lubricated, and featuring universal mounting, it is easily incorporated in your power transmission systems and requires little or no maintenance.

You can specify standard ANGLgear in ⅓, 1, 2¼ and 5 hp ratings, with 1:1 or 2:1 gearing and 2 or 3-way shafting. See data in Sweet's Product Design File or contact our local distributor.



AIRBORNE®

AIRBORNE ACCESSORIES CORPORATION
HILLSIDE 5, NEW JERSEY

Circle 555 on Page 19

woven glass-fiber cloth, cotton duck, or other fabric. It is also available with a pressure-sensitive adhesive backing, making it easy to apply to metal and other surfaces. It is furnished in several different weights, and can be obtained in rolls from 1 up to 36 to 38 in. It has application as a lining for many types of noisy machinery, business machines, and can be used in wind tunnels, computers, and office wall panels. Material is especially adaptable for use as folding separator partitions. Fabric has good fire resistance. Weight ranges from 0.25 to 1.3 lb per sq ft. **Cordo Chemical Corp.**, 34 Smith St., Norwalk, Conn. B

Circle 775 on Page 19

Check Valves

cover range of flow from 3 to 50 gpm

Two models of steel hydraulic check valves are spring-loaded cone type for in-line installation. Valves cover a range of rated flow from 3 through 50 gpm, and maximum recommended operating pressure is 3000 psi. Cracking pressure can be either 5 or 65 psi. Model VCL-F has Triple-lok flare ends for connecting JIC 37-deg flared tubing. Size range is from ⅜ through 1¼ in. OD tubing. Model VCL-P has female pipe-thread ports ranging from ¼ through 1¼ in. sizes. **Parker Hydraulics Div., Parker-Hannifin Corp.**, 17325 Euclid Ave., Cleveland 12, Ohio. F

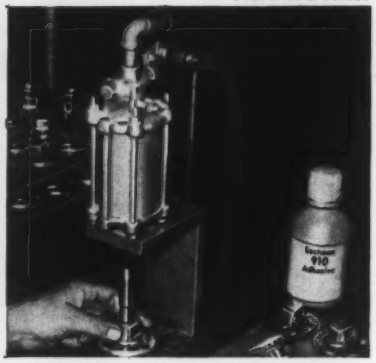
Circle 776 on Page 19

Titanium Fasteners

are strong and lightweight

Titanium bolts, nuts, and washers have been added to a line of more than 7000 types and sizes of fasteners. The strong, lightweight units are precision manufactured to

No. 7 of a series



Eastman 910 Adhesive solves another production bottleneck

Cinaudagraph, Inc. of Chicago, Illinois, manufactures radio and television speakers.

By switching from soldering to bonding with fast-setting, high-strength Eastman 910 Adhesive, Cinaudagraph eliminated a bottleneck in the assembly of a 2¾ inch speaker for portable transistor radios.

The adhesive bonds the pole tip to the magnet and the pole tip-magnet assembly to the speaker yoke, with excellent magnetic continuity.

The adhesive has been used successfully on more than 100,000 speakers. *Material costs were reduced 25%—labor costs, 50%.*

Eastman 910 Adhesive is making possible faster, more economical assembly-line operations and new design approaches for many products. It is ideal where extreme speed of setting is important, or where design requirements involve joining small surfaces, complex mechanical fasteners or heat-sensitive elements.

Eastman 910 Adhesive is simple to use. No mixing, heat or pressure is required. Upon spreading into a thin film between two surfaces, setting begins immediately. With most materials, strong bonds are made in minutes.

What production or design problem can this unique adhesive solve for you?

For a trial quantity (⅓-oz.) send five dollars to Armstrong Cork Co., Industrial Adhesives Div., 9111 Dean Street, Lancaster, Pa., or to Eastman Chemical Products, Inc., Chemicals Div., Dept. M-11, Kingsport, Tenn. (Not for drug use)

Circle 556 on Page 19

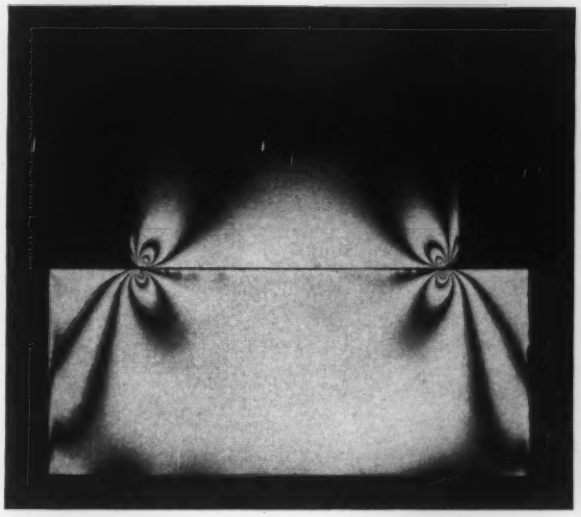
TEAR OUT AND PUNCH AS INDICATED FOR YOUR FILE

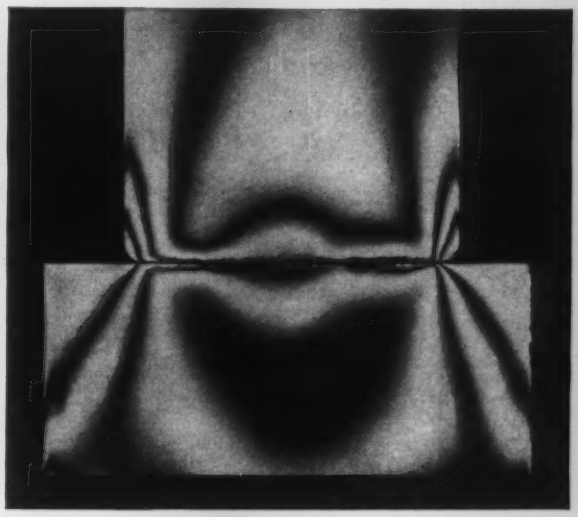
TEAR OUT AND PUNCH AS INDICATED FOR YOUR FILE

One in a series of technical reports by Bower

BEARING BRIEFINGS

ROLLER BEARING LIFE AND CAPACITY LINKED TO STRESS DISTRIBUTION





These reproductions of photoelastic studies contain important evidence for every engineer and designer concerned with the performance and selection of roller bearings. In these photographs, the alternate dark and light areas, called fringes, indicate not only the magnitude of stress but also the stress distribution. The photographs were taken by Bower Research Engineers during a study of stress distribution in roller bearings.

The subjects represent rollers and raceways of two roller bearings under identical loads. The illustration at the left shows a roller of conventional design. The illustration at the right shows a Bower "Profiled" roller. That is, the roller is precision ground with a large radius generated along the body of the roller—a predetermined and controlled distance from each end.

The conventional roller photo (left) clearly shows how, under load, stress concentration builds up in and near the roller ends. This is called edge-loading. Such areas of concentrated stress are the breeding grounds for metal fatigue and eventual bearing failure.

In the photo of the "Profiled" roller (right) stress lines can be seen uniformly distributed across the whole length of the roller and raceway. There are no points of excessive stress concentration, consequently no starting points for early fatigue. Such a "Profiled" roller exhibits a great advantage in improved load carrying capacity, a most important bearing requirement.

Under actual operating conditions, Bower "Profiled" roller bearings show a considerably longer life at higher speeds and under greater loads than conventional roller bearings.

Because of this, and of other Bower features to be discussed in later technical reports, we suggest that you consider the advantages of Bower bearings in satisfying your future bearing requirements.

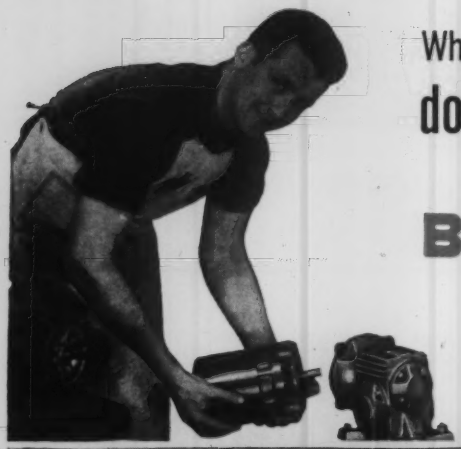
★ ★ ★ ★

Bower engineers are always available, should you desire assistance or advice on bearing problems. Where product design calls for tapered roller bearings or journal roller assemblies, Bower makes these also in a full range of types and sizes.

BOWER ROLLER BEARINGS

BOWER ROLLER BEARING DIVISION — FEDERAL-MOGUL-BOWER BEARINGS, INC., DETROIT 14, MICHIGAN

Circle 557 on Page 19

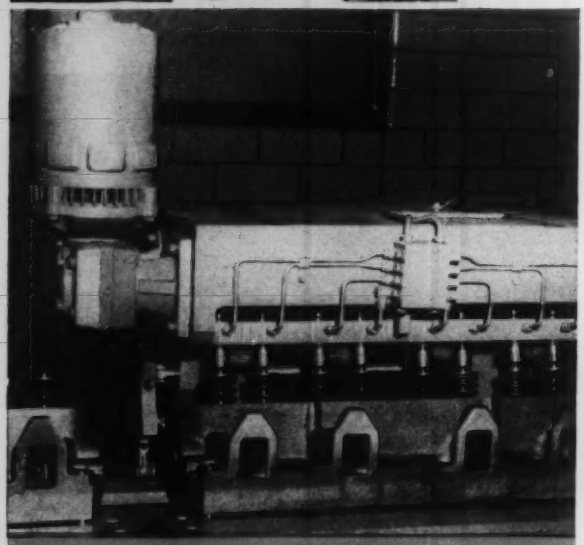


Where continuous automatic operations demand double insurance against downtime

the leading choice is standardized

BOSTON Gear® SPEED REDUCERS

NO DOWNTIME for motor repairs. The standard end-mounted motor on BOSTON Gear RATIOMOTORS is easily detached by removing the bolts holding the motor to the gear unit flange. A spare motor can be attached, and operations resumed in a *few minutes*. Gear unit remains undisturbed, preserving alignment.



BOSTON Gear Vertical Right Angle RATIOMOTOR drives the valve "popping" (final test) unit in a giant 29-station transfer machine for continuous automatic assembly of cylinder heads.

BOSTON Gear Horizontal Right Angle RATIOMOTORS drive magnetic belts which convey parts from lower storage bins to vibratory hoppers at start of 13-station, automatic assembly of roller skate wheels.

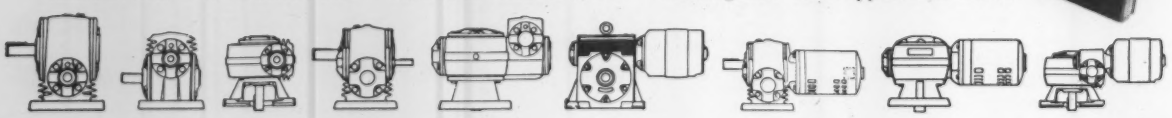
BOSTON Gear RATIOMOTORS are the leading choice for all types of installations where downtime would be disastrous to production schedules. One reason is BOSTON Gear quality standards, which assure highest efficiency and extra service life of the gear unit. Another is BOSTON Gear design leadership like the detachable motor which permits continued operation with a spare, avoids downtime. Design around BOSTON Gear RATIOMOTORS for this *double* insurance against downtime. All types and ratios are *standardized stock* models, quickly available anywhere from over 100 BOSTON Gear Distributors. Boston Gear Works, 64 Hayward Street, Quincy 71, Massachusetts.

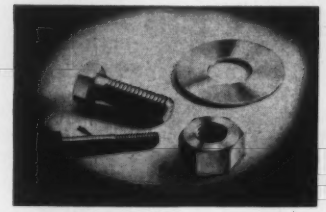
Advt. copyright by Boston Gear Works

From Stock!
AT YOUR NEARBY BOSTON Gear DISTRIBUTOR

— STANDARDIZATION PAYS —®

REDUCTORS — RATIOMOTORS — FLANGED REDUCTORS — Catalog lists 1605 types and ratios





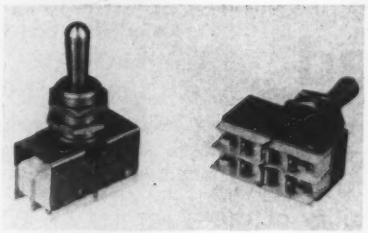
meet exact tolerances and rigid specifications. **Star Stainless Screw Co.**, 699 Union Blvd., Paterson 2, N. J. D

Circle 777 on Page 19

Toggle Switch

four-pole unit is small, lightweight

Toggle switch, designed for aircraft and military use as well as for compact pane control panels on electrical and electronic equipment, contains four poles, yet occupies less than 1 cu in. of space below panel. All exposed metal parts are stainless steel or are treated for corrosion resistance. Operating force required to move bat handle is set above point where vibration or accidental jarring will actuate switches. Detent action gives positive feel to movement of bat handle from one side to the other. Each pole of switch element is rated at 6 amp,



125/250 v ac, 30 v dc, desistive, and 3 amp, 30 v dc, inductive. Weight is approximately 1 oz. **Electrosnap Corp.**, 4218 W. Lake St., Chicago 24, Ill. J

Circle 778 on Page 19

O-Ring Retainers

metallic assemblies match many flange configurations

Metallic O-rings have been incorporated into one metallic assembly. Several different hole patterns and sizes are designed to match various flange configurations. Rings so contained are of the same metal, cross-

New UNION readout instruments withstand shock, vibration and extreme temperature changes

Union Switch & Signal's new READALL* readout instrument replaces complicated systems of lights and relays for reading, storing or transferring all types of information for industrial and military applications. It is not to be confused with conventional indicating devices.

Designed to meet requirements of MIL-E-5422D. The new READALL readout instrument is precision-built and provides instantaneous and continuous operation under conditions of shock, vibration and extreme ranges in temperature. The digital display includes characters in numerical sequence from 0 to 9 plus two blank spaces. 7/32-inch characters can be illuminated red or white as desired; when not illuminated, they appear white against a black background.

Reliability. Performance through one million random operations is an inherent feature of the new READALL instrument. Each module is gasket-sealed in its case to exclude moisture and seal out foreign particles. An especially thin enclosed DC motor, containing ball bearings, permits more efficient operation.

Modular Construction. A unique feature of the readout instrument is its modular construction. It can be used individually or in groups to display multiple characters in a single case.

Direct Code Translation. The operation of the READALL readout instrument is based on a positioning system using a four-bit code. The visual display is the result of a direct electro-mechanical conversion of a binary signal to a decimal read-out. There is no need for additional conversion equipment. Separate code and motor circuits permit the use of the readout instrument in low-level circuitry.

Electrical and Visual Data Storage. Once positioned, the information is displayed until a new code is transmitted to the instrument. No power is consumed while the information is retained. This data may be stored or read-out electrically for further transmission or recording.

Operate Time. The operate time varies from 0.1 second to 1.0 second depending on character position.

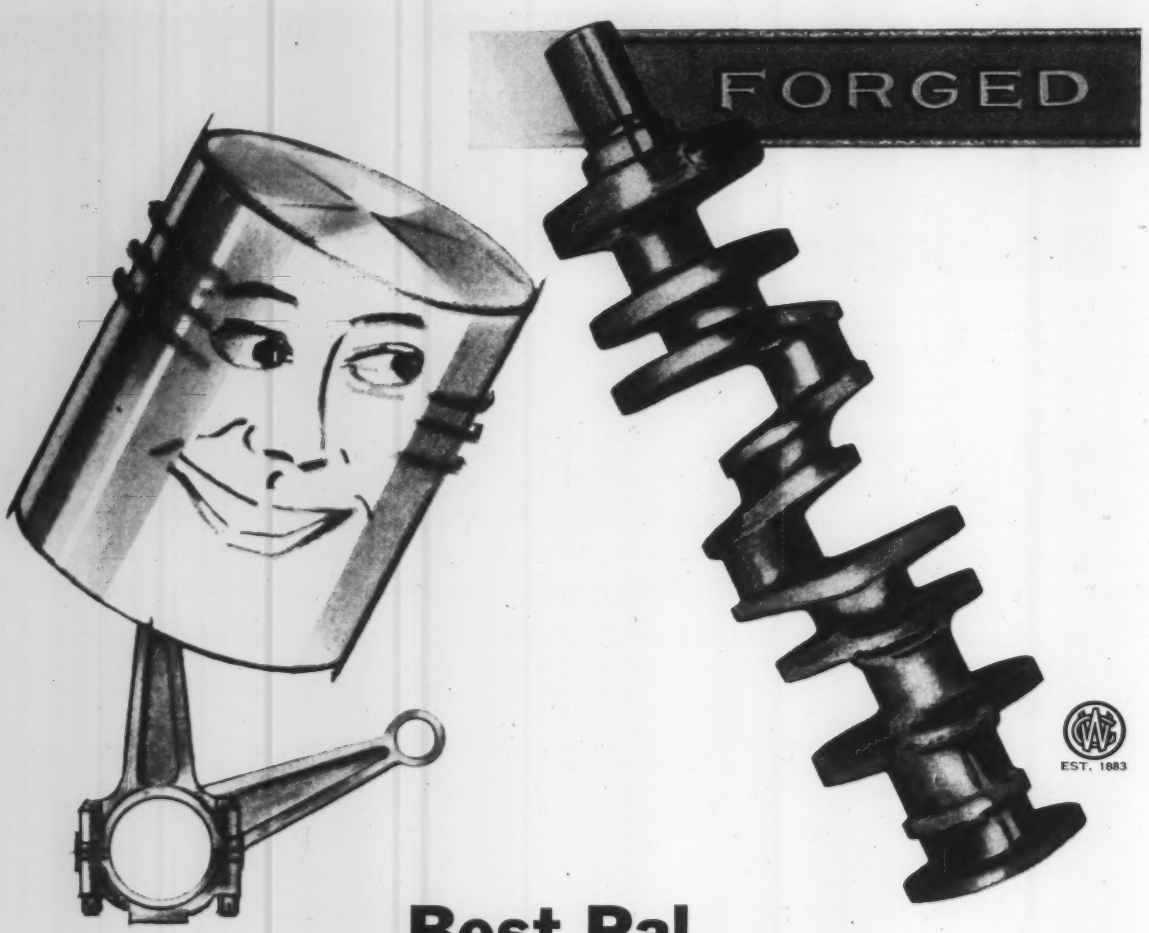
Weight and Size. Maximum weight including case is seven ounces; without case, four and one-half ounces. Size encased is 5 13/64 inches long, 1 47/64 inches high and 3/64 inch wide. The new READALL instrument is designed for operation over a temperature range of −54°C to +71°C in humidities up to 100% and altitudes up to 70,000 feet. For more information, write for Bulletin 1019.

*Trademark

"Pioneers in Push-Button Science"

UNION SWITCH & SIGNAL
DIVISION OF WESTINGHOUSE AIR BRAKE COMPANY
PITTSBURGH 18, PENNSYLVANIA

Circle 559 on Page 19



Best Pal
a Piston ever had

Crankshafts have been made successfully by other methods of fabrication and have proven good enough for certain non-critical applications—but for maximum dependability of the modern, compact, high-compression, high-torque, heavy-duty engine a forged crankshaft is essential.

In a crankshaft there is no substitute for a forging, and in a forging there is no substitute for Wyman-Gordon quality and experience.

WYMAN-GORDON

FORGING

Aluminum *Magnesium* *Steel* *Titanium* *Beryllium* *Molybdenum* *Columbium*

WORCESTER MASSACHUSETTS

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DETROIT MICHIGAN
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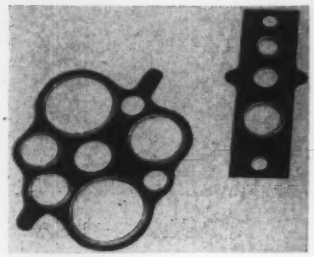
FORT WORTH TEXAS
FRANKLIN PARK ILLINOIS
LOS ANGELES CALIFORNIA

Circle 560 on Page 19

section, OD, and wall thickness so that bolt-loading factor will be effective across the entire surfaces of mating flanges. Rings, press fitted without cross-section distortion, are secured against drop-out and possible contamination or loss, and are easily handled. Assembly also furnishes an automatic O-ring compression limit, positions multiple O-rings for accurate matching of



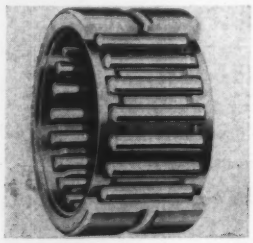
multiple-hole patterns in mating flanges, controls hoop tension of ring, permits interchangeability of flanges, and applies to single or multiple metallic O-ring requirements. Retainer plates are available to meet requirements of most two-dimensional junctures, regardless of number of ports. **United Aircraft Products Inc.**, Dept. R, Box 1035, Dayton 1, Ohio. G

Circle 779 on Page 19

Roller Bearings

have one-piece cage design

Channel-shaped outer-ring roller bearings utilize one-piece cage which permits application of bearings at speeds higher than those attainable with full-complement types. Longer and larger rollers result in greater capacities than previously available. Made in sizes from ¾ to 4 in. bore, designated Series HJ, bearings can be applied directly to hardened and ground shafts or can be used with inner rings which are also available. Boundary dimensions conform to standard AFBMA series

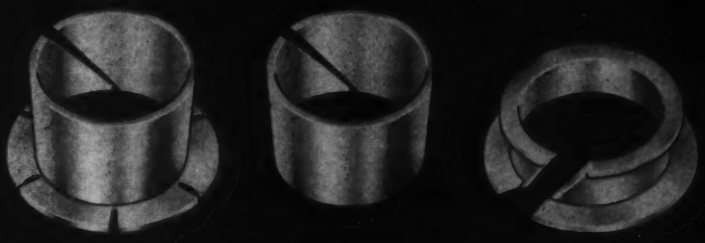


Circle 561 on Page 19→

LONG LIFE, *THOMSON* "Snap-In"

NYLINERS

of smooth, tough DuPont NYLON



Low Cost FLANGED Nyliner

Low Cost SLEEVE Nyliner

Low Cost DOUBLE-FLANGE Nyliner

BETTER BEARINGS THAT...

• COST LESS to BUY*

• COST LESS to INSTALL

& ELIMINATE LUBRICATION

Additional Benefits:

- CLOSE FIT
- LONGER LIFE
- EASILY INSTALLED
- LESS SERVICING
- SELF-RETAINING
- RESIST CORROSION
- LOW FRICTION
- RESIST POUNDOUT
- NO FRICTION OXIDATION
- DAMP VIBRATION
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- NON-CONTAMINATING
- INSTANTLY REPLACEABLE
- RESIST ABRASION
- MINIMUM SPACE
- SILENT OPERATION
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Engineered to Solve Problems . . . Improve Products . . . Reduce Costs!

NYLINER Bearings are a highly engineered thin liner of DuPont Nylon, designed to bring bearing users the many benefits of Nylon as a bearing material by solving most of the limitations surrounding its use. The compensation gap principle assures maintenance of diametral tolerances for precision applications.

Seven Standard Types available from stock. Write for literature and name of your local representative who stocks NYLINER Bearings for immediate shipment.

**In production quantities at new, REDUCED PRICES.*

THOMSON INDUSTRIES, Inc.

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Also— —Manufacturers of BALL BUSHINGS . . . the Ball Bearing for Linear Motions and 60 CASE . . . Hardened & Ground Steel Shafting

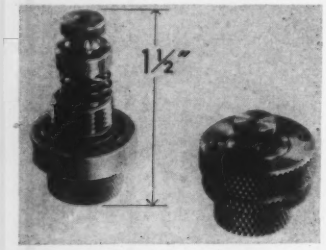
NAA and NAB, and bearings are interchangeable with needle bearings made to these standards. Design provides long service life and combines effective roller guidance, low internal friction, and generous provision for lubrication to allow operation at higher speeds. **Torrington Co.**, Torrington, Conn. B

Circle 780 on Page 19

Flow-Control Unit

permits presetting of small rates of flow

Developed for a wide variety of applications, Microflow unit incorporates an adjustment enabling presetting for desired rate of flow to fractions of a cc per minute. It functions without use of springs, diaphrams, or other mechanical con-



trol means. Device features an elongated, groovelike orifice machined to permit minute flow. It maintains rate of flow presettings despite rough handling, and can be assembled and disassembled without changing flow characteristics. **Acme Industrial Co.**, 200 N. Laflin, Chicago 7, Ill. I

Circle 781 on Page 19

Zippered Tubing

permits breakdown of large-diameter cables

Multichannel Zippertubing, for use where space and flexibility are important factors, permits large-diameter cables to be broken down into two or more smaller cables. Tubing can be used in cables between bulkheads, under floors, as flexing on doors or drawers, and in other tight areas. Cables can be of the same or different diameters, and can be sealed together and branched off into desired locations. Tubing is available in vinyl plastic for general usage, in Type 74 polyvinyl chloride for airborne applications

FORMULA FOR REDUCED ASSEMBLY COSTS

You choose a tubular rivet for your design because of its low-cost efficiency. But what you save at the design stage may be lost in production unless parts are riveted with automatic riveters. Milford Tubular Rivets and Riveters should be paired for maximum cost savings. Mention this to your production engineers.

For the answers to assembly problems *get in touch with Milford first!*

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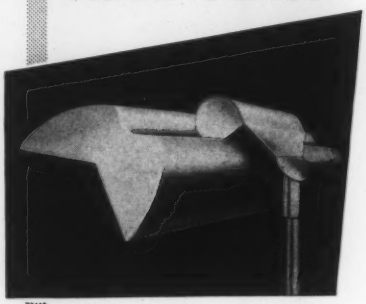
Circle 562 on Page 19

Another product made better with MOLDED FIBER GLASS



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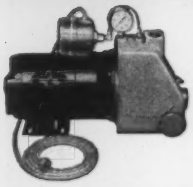
Franklineering® a product improves performance—longevity while costs are lowered.

This is why more and more manufacturers build Franklin Electric Motors into their finest, best-selling, powered products

Product dependability is never compromised when Franklin application-engineering cuts costs. Fewer parts, less weight, reduced assembly time are typical reasons Franklineering pays.

FRANKLIN'S APPLICATION-ENGINEERING CAPABILITY IS BASED ON EXPERIENCE IN MANY PRODUCT AREAS . . .

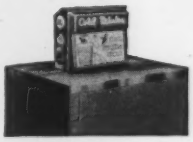
UNISEAL MOTORS
Built-in seal cavity permits close-coupling pump to motor.



PUMPS

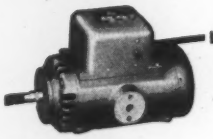
Franklineering eliminated a large casting, a stub shaft extension, four bolts, and saved tubing, fittings and wiring in the water pump at left.

DISPENSER MOTORS
Small pump unit mounts on the motor.

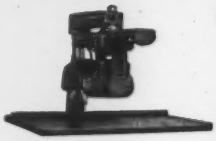


DRINK DISPENSERS

Franklineering eliminated a belt, sub-base and open couplings; and reduced assembly time. Resilient mount stopped noise in machine shown.



LO-SHAFT MOTORS
Bosses permit precision trunnion mounting.



POWER SAWS

Franklineering reduced shaft height, maintained high torque for direct mounting. Controls sealed against dirt in motor-mounted box illustrated.

HI-TORQUE FARMOTORS
Integral ratings have full-power start capacities.

FARM APPLIANCES

Franklineering provided totally-enclosed, heavy duty motors for close-coupling on feed mill pictured. Same motor also powers other farm equipment.

INST-O-VERSE GEAR MOTORS
Available in output shaft speeds needed.

HOSPITAL BEDS

Franklineering originated new instant-reversing mechanism with arcless switch to meet UL approval for hospital environment. Motor shown has 3 output shafts.

Franklin Electric Co., Inc.

BLUFFTON, INDIANA

HOME OF DEPENDABLE ELECTRIC MOTORS

WRITE FOR CATALOG
Contains cost-cutting ideas to interest performance-minded product designers...

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OPEN UP

... with the all-new PM-1 line of permanent-magnet d-c motors for your hard-to-fit applications. Only ⅞ inches in diameter, under 2 inches long and weighing less than 2½ ounces, these motors give you equivalent output power with ⅓ less bulk than older designs. And they're self-shielding.

Motors are available governed or ungoverned, with a choice of bearings, shaft extensions, and mounting arrangements; gear motors with various speed reductions. Modifications can be made to meet military and other special requirements.

ONLY ⅞ INCHES IN DIAMETER JUST 2½ OUNCES

● STOCK MODELS FROM 4-30 VDC ● EFFICIENCIES FROM 40-50%

● CERAMIC FIELD STRUCTURE ● SELF-SHIELDING

● SPEEDS TO 20,000 RPM ● VIBRATION- AND SHOCK-RESISTANT

WRITE TODAY for complete specifications, including information about Reflectone's unique self-contained POWER-PAK, a complete, compact electromechanical subassembly to simplify your design problem. One component provides mechanical output and d-c power for associated circuitry from AC, DC or self-contained battery.

"THE D-C WAY IS THE MODERN WAY"

Design d-c for maximum flexibility, portability, simplicity and dependability.

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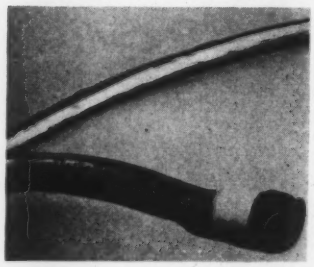


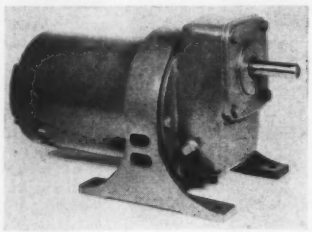
where cable is subjected to temperatures from −90 to +185 F, and in Type 63 polyvinyl chloride, a flexible, high-temperature tubing. Black and natural tubing are carried in stock, with any standard colors also available upon request. **Zippertubing Co.**, 752 S. San Pedro St., Los Angeles 14, Calif. L

Circle 782 on Page 19

Gear Motors

fractional-horsepower units are lightweight

AC fractional-horsepower gear-motor line includes new lightweight models in ratings from ⅛ to ¾ hp. Models have right-angle and integral-type designs, with output speeds, respectively, of 197 to 6 rpm,



and 780 to 13.5 rpm. Integral type with offset shaft is shown. **General Electric Co.**, Schenectady 5, N. Y. C

Circle 783 on Page 19

Rectangular Power Connector

miniature unit is for heavy-duty applications

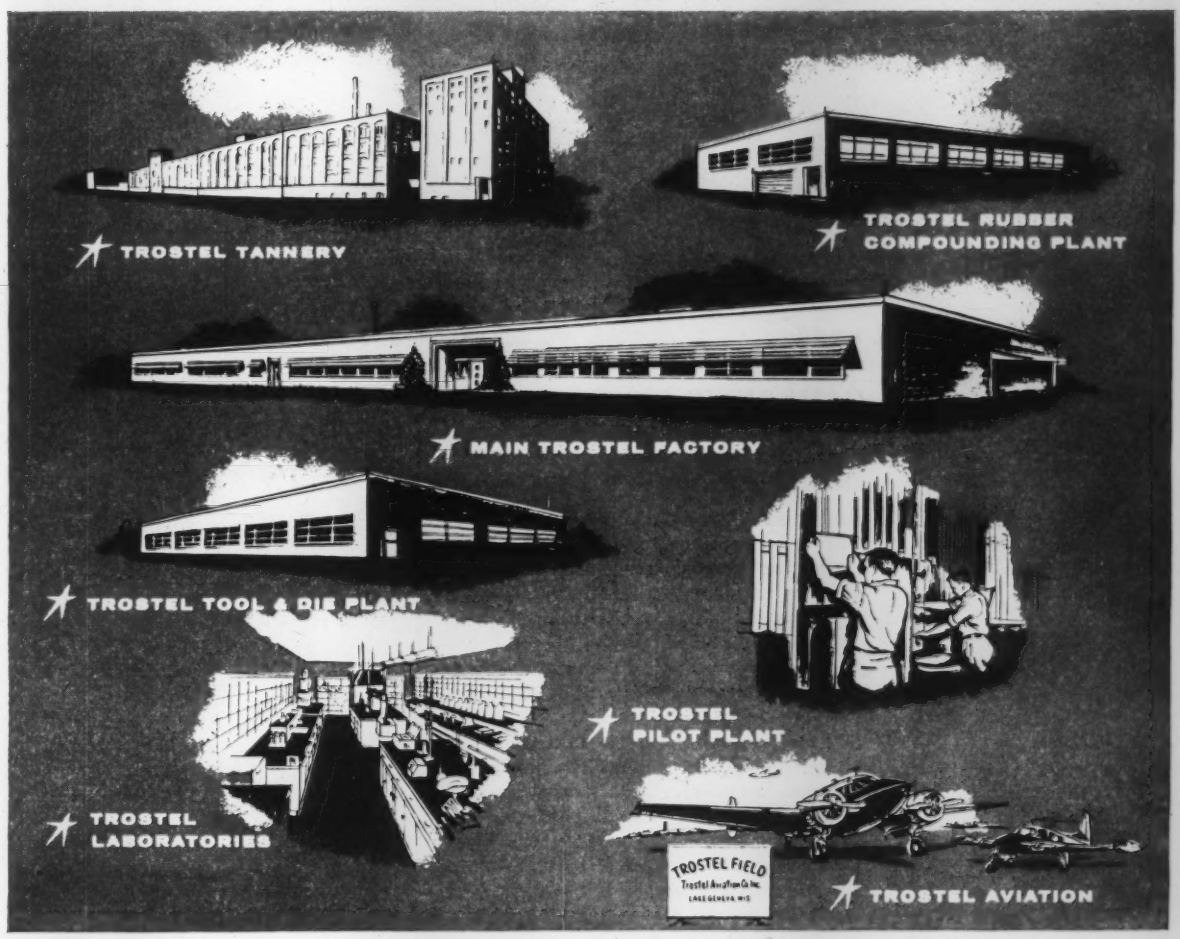
Series 1900 miniature rectangular power connector has center screw-lock and closed-entry contacts. Pin-and-socket connector is designed for heavy-duty applications in critical electronic equipment. It has high dielectric and mechanical strength, and features stainless-steel channels riveted to long sides of plug and receptacle. Double - lead,

Circle 564 on Page 19

TROSTEL

A complete producing organization for

☆OIL SEALS ☆PACKINGS ☆O-RINGS



Quality in every phase of supply and manufacture is assured through Trostel ownership of all essential facilities

From raw materials to finished product, all key sources of supply and manufacture are Trostel owned and operated. Leather is tanned at the Trostel Tannery. Rubber is compounded at the Trostel Compounding Plant. Dies are made at the Trostel Tool and Die Works. Three separate Trostel Laboratories conduct research in leather, impregnations, and synthetics. A pilot plant tests all production runs. When, therefore, parts and materials arrive at the point of manufacture into seals and packings they are uniformly standard in specifications. Manufacture itself is by automatic machinery in a modern plant, with a quality control system that insures close-tolerance accuracy in all operations. Special delivery and service are provided by Trostel Aviation . . . we can come to you quickly, or bring you to us.

Trostel control of its products from raw materials to delivery is your guarantee of dependably high quality at all times, on every order. For catalog and technical data, write Albert Trostel Packings, Ltd., 600 Madison St., Lake Geneva, Wis.

TROSTEL
QUALITY
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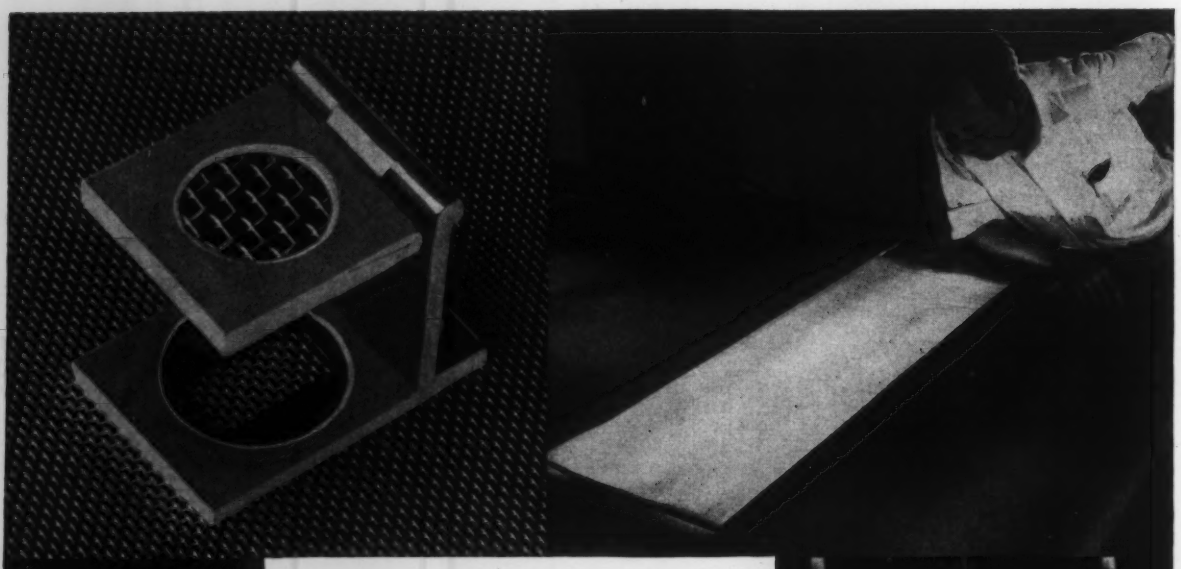
PACKINGS
OIL-SEALS
O-RINGS

Circle 565 on Page 19



Who counts 'em?

CAMBRIDGE does . . .

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But, quality isn't the whole story. When you call Cambridge for industrial wire cloth, you also get service . . . prompt answers to your inquiries . . . quicker deliveries . . . and an experienced Field Representative who follows up your order to make sure our product is giving you the best possible service. Let us quote on your wire cloth needs. We manufacture wire cloth from any metal or alloy—including titanium—in nine basic weaves. Very likely, we have what you require in our warehouse right now. For samples or more information, call your Cambridge Field Engineer...he's listed in the yellow pages under "Wire Cloth". Or, write for FREE 94-PAGE CATALOG.

The Cambridge Wire Cloth Co.

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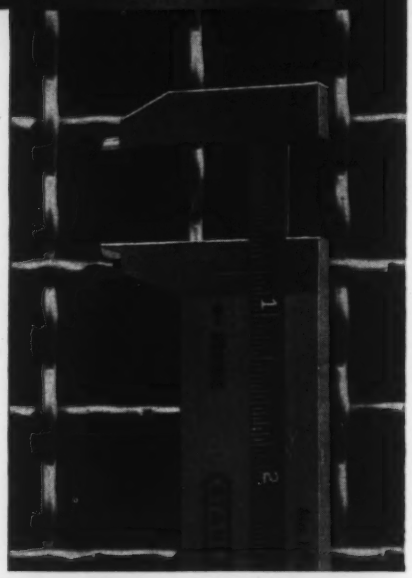
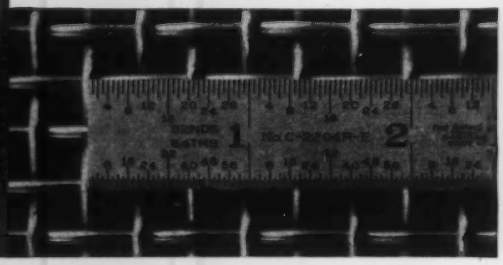
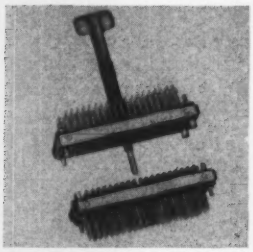
Manufacturers of Wire Cloth, Metal-Mesh Conveyor Belts, Wire Cloth Fabrications







thread-action center screwlock assures positive locking action of mating units. Terminals for solderless wire wrap, solderless taper pin, or solder cup are available. In addition to 152-contact type illustrated, unit can also be supplied with 104, 78, or 34 contacts. Body material is molded from glass-filled diallyl phthalate. **Electronic Sales Div., DeJur-Amsco Corp.**, 45-01 Northern Blvd., Long Island City 1, N. Y. D

Circle 784 on Page 19

Encapsulating Resin

has low working viscosity

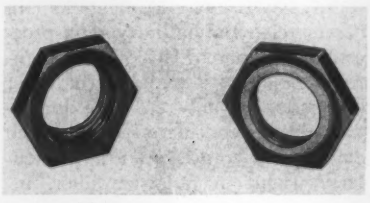
RF-95545 resin system with low working viscosity is available for the potting and encapsulation of electronic equipment which is required to withstand high temperatures or chemical attack. Heat distortion after postcure is at 375 F. Dielectric strength is 500 v per mil, tensile strength is 7000 psi ±2000, and compressive strength is 22,750 psi ±2000 psi. Material is available in ten standard colors. **Resin Formulators Inc.**, 8956 National Blvd., Los Angeles 34, Calif. L

Circle 785 on Page 19

Self-Sealing Nuts

eliminate leaks on all pipe threads

Installation of Tef-Seal nuts, together with usual fittings, eliminates leaks on all pipe threads, dry seal or standard. Nuts also serve as an economical substitute for straight-thread, O-ring boss fittings



INTRODUCING THE SIGMA MODELS FOR 1960

Total newness is only one of the exciting features of these 1960 Sigma relays. Eager in performance, nimbly darting around the worst circuit parameters, they bring back that forgotten thrill of the first time you got a relay to work in a circuit — and they win the respectful admiration of all your electronic colleagues. No matter what your reason for owning a relay, there's a new Sigma model — standard luxury or fully equipped — to make every magnetic excursion fun again!

All 1960 models come with coils wound with genuine wire, potentially movable armatures, and 100% fresh magnetic fields created by Sigma master craftsmen, at no additional cost. (Models illustrated include optional extras available at added cost — ohm grown resistance values, dry circuit quencher and Braintree Beige enclosures.)

Decide now to be unhappy with anything less than a 1960 Sigma relay. Make your status clear — fulfill your desire to be known as one who dares to be different . . . one who uses Sigma relays. And always remember: when better relays are built, Buick will build them.

SIGMA

SIGMA INSTRUMENTS, INC.
89 Pearl St., So. Braintree 85, Mass.
An Affiliate of The Fisher-Pierce Co. (since 1939)

Circle 567 on Page 19

new Mac-it IB Socket Head Cap Screw

provides a 26.53% improvement in working efficiency!

(Even over the new 1960 Series)

The taper tells the story. It's the taper of the new Mac-it IB socket head cap screw that adds 16.66% *more bearing surface* without an increase in head size. And there's 14.28% *less resultant compression* because of the change in direction of stresses.

It takes 12% to 23% more torque to release a Mac-it IB screw. That means it holds tighter. Indenting and corner fatigue are eliminated. And the new IB is self-aligning, tight-sealing, stronger, yet more streamlined.

Conservatively rated, the Mac-it IB socket head cap screw provides a 26.53% improvement in working efficiency.

YOUR MAC-IT DISTRIBUTOR will be glad to give you the facts on the new IB's right now; or *write for new, illustrated specifications bulletin.*

Mac-It Parts Co., Dept. 21, Lancaster, Pa.

Mac-it ®

MAC-IT ALLOY STEEL SCREWS

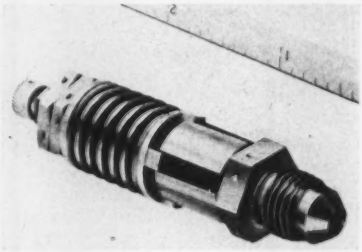
using original female pipe ports. They give positive seal on directional fittings like tees and elbows without distorting mounting bosses or damaging valves and pumps. Quick, easy installation is assured, even in cramped quarters where wrench clearance is limited. Nine sizes fit pipe threads from 1/8 to 2 in. **Ft. Wayne Div., Weatherhead Co.**, 128 W. Washington Blvd., Ft. Wayne, Ind. J

Circle 786 on Page 19

Relief Valve

for hot-gas service to 2000 F

Model 2200 relief valve has no rubber or organic parts, and is constructed entirely of stainless steel. It is designed for hot-gas service to 2000 F. Valve provides a narrow pressure-control band without drift



when used to control pressure of solid - propellant gas generators. Cracking pressure is adjustable from 1000 to 15,000 psi, and hysteresis is less than 5 per cent. Mass flow capability is greater than 0.015 lb per sec at 1000 psi. Unit mounts on MS-33656-4 fitting and weighs 2 oz. **Pyronetics**, 11937 E. Slauson, Santa Fe Springs, Calif. L

Circle 787 on Page 19

Mesa Transistors

for high-speed switching uses

No. 2N1300 and 2N1301 germanium p-n-p diffused-junction mesa transistors are designed for high-speed switching applications in commercial and military data-processing equipment in which high-frequency response and high power dissipation at low cost are important design considerations. In such equipment, transistors are particularly useful in pulse-amplifier, in-

YES

OR

Ten-second quiz for people who buy, operate or maintain electrical adjustable speed drives

YES	NO	
☐	☐	Adjustable speed drives should be simple to install, operate, and should require little or no maintenance.
☐	☐	Adjustable speed drives should offer a wide range with either constant torque or constant hp, and should offer smooth acceleration and deceleration.
☐	☐	Adjustable speed drives should offer high operating efficiency . . . and be adaptable to a wide range of motor sizes.
☐	☐	Adjustable speed drives should provide the required flexibility and inherent reliability for any type of application . . . intermittent or continuous.

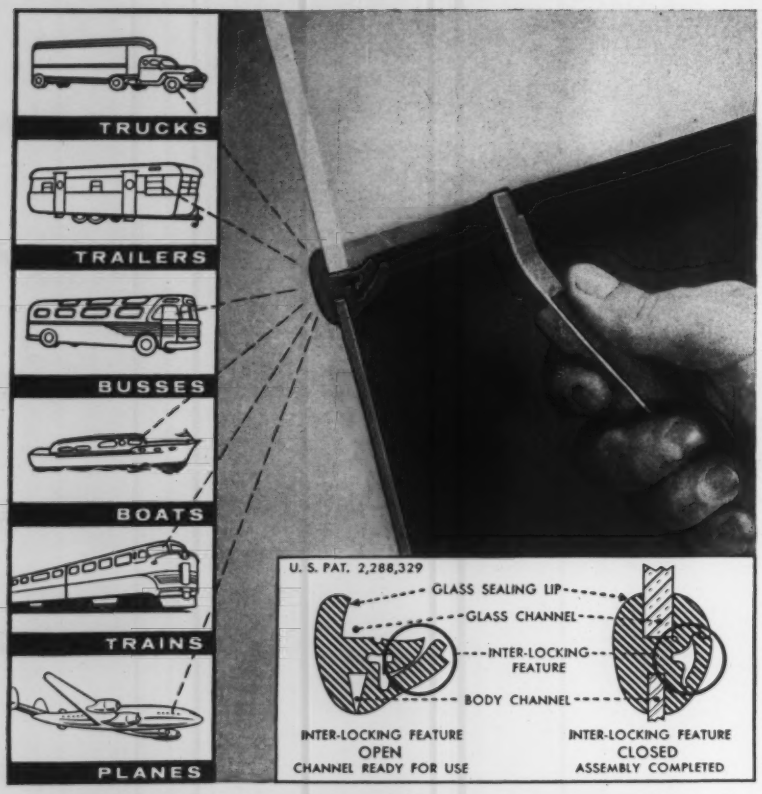
If you have answered "yes" to the above questions, then you will be very much interested in obtaining complete information about the *all-new, static-powered* Westinghouse Adjustable Voltage Reactifier drive . . . (Type AVR). This new drive not only meets all of the above requirements, but also gives you many other advantages to perform a better job at lower cost. Ask your Westinghouse sales engineer to show you exactly where and how this new drive can benefit you. Or, write to Westinghouse Electric Corporation, P. O. Box 868, Pittsburgh 30, Pennsylvania.

J-22104

YOU CAN BE SURE... IF IT'S Westinghouse

Circle 569 on Page 19

WATCH "WESTINGHOUSE LUCILLE BALL-DESI ARNAZ SHOWS" CBS TV FRIDAYS



Self-Locking Rubber Channel for Mounting Glass in Body Panels

Its *one-piece* design locks and seals in one operation. No extra locking-strip needed. It's the faster, simpler method for mounting glass in any type body panel—truck, trailer, bus, boat, train, plane, etc.

Extruded with inter-locking feature at direct right angle to body, the Continental Channel permits unhampered insertion of glass. Locking tongue is pressed into its matching groove which forces the lips against *both* the glass and body panel—a more positive seal with exceptional push-out pressure.

Compounded for maximum weather resistance and extra long life. Close durometer tolerances are held for uniformly tight seal against moisture and surest possible locking. These rubber channels can be positioned first on *either* glass or body panel. All details are shown in illustrated brochure gladly sent on request.

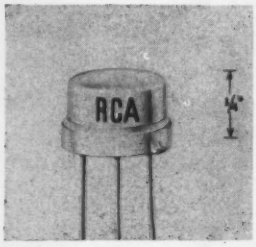
Ordered and re-ordered by the most prominent body builders, this Self-Locking Channel is another example of the creative thinking and ingenuity behind rubber parts by Continental. When you need rubber parts to do a specific job, call a rubber specialist *during the planning stage*. This often makes for economy as well as better end results. Call Continental —rubber specialists since 1903.

Engineering catalog.

In addition to custom-made parts, Continental offers an extensive line of standard grommets, bushings, bumpers, rings and extruded shapes. Hundreds of these are shown in the No. 100 Engineering Catalog. Send for a copy or refer to it in Sweet's Catalog for Product Designers.

Another achievement in **RUBBER**
engineered by **CONTINENTAL**

CONTINENTAL RUBBER WORKS • 1984 LIBERTY ST. • ERIE 6 • PENNSYLVANIA



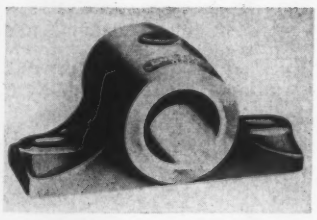
verter, flip-flop, and logic-gate circuits. Units feature rugged mesa structure with extremely small base width to insure top performance at high frequencies, high power dissipation, high current gain, high breakdown voltage and punch-through voltage ratings, and fast switching speeds. Transistors are hermetically sealed in welded metal cases and have dimensions corresponding to JEDEC dimensional outline No. TO-5. **Semiconductor and Materials Div., Radio Corp. of America**, Somerville, N. J. D

Circle 788 on Page 19

Bearing Blocks

in 45 new sizes and five series

Line of babbitted and bronze bearing blocks has been increased by 45 new sizes in five series. Series 1000-Z pillow blocks, solid gray-iron housing with bronze bearings (shown), have two-bolt bases and are used for general applications where cap removal is not required. Series 2-1400 blocks have split, gray-iron housings with babbitted bearings. Series 2K-1400Z blocks have split, cast-steel housings with bronze bearings. Both blocks have four-bolt bases and machine-finished gibbed joints. They are used for a variety of applications where heavy side pressures are present and where removable caps are advantageous. Series 2-1500 pillow blocks have split, gray-iron housings with babbitted bearings, and Series 2-1500Z blocks have split, gray-iron hous-



Circle 570 on Page 19

announcing the

INDUSTRIAL DIVISION . . .

now supplying

electrohydraulic servo components

and systems

for industrial applications

from **MOOG:**

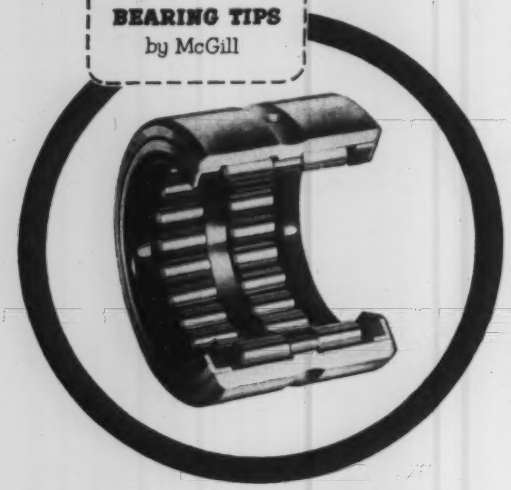
. . . the leading innovator and largest manufacturer of electrohydraulic servovalves

. . . pioneer in the application of electrohydraulic servos to critical control problems.

MOOG SERVOCONTROLS, INC. INDUSTRIAL DIVISION EAST AURORA, N. Y.

WRITE for bulletin PB—110 describing electrohydraulic servocontrol applications

BEARING TIPS
by McGill



McGILL sealed GUIDEROL® bearings preserve high capacity performance of needle bearing applications

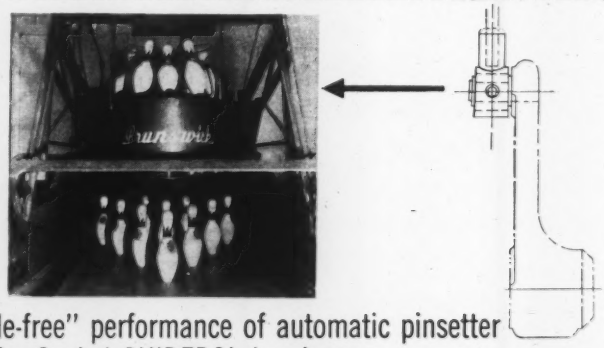
Lip type contact seals built into GUIDEROL bearings insure longer life for their high capacity performance in limited radial space. It's simpler and less costly to apply these sealed bearings than build in auxiliary seals that increase bearing width and housing requirements.

GUIDEROL bearings, including the sealed series, are precision built and combine the inherent high capacity of full complement roller bearings with the control of center guided rollers. This recommends the bearing for applications too heavily loaded for retainer type bearings, but where shaft deflection and misalignment prevents the use of ordinary full type roller bearings.

Seals keep contamination out and lubrication in. This assures trouble free performance where maintenance is costly or impractical.

Sealed GUIDEROL minimizes torque in ACF "Piggy-Back" trailer hitch

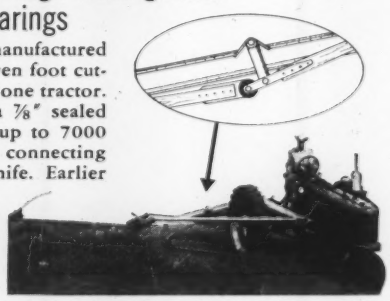
McGILL Sealed GUIDEROL bearings meet the requirements of a high capacity needle bearing for small radial space, having adequate seals to prevent entry of foreign materials and loss of lubricant in this exposed application. The bearings, in the elevating arms, minimize the amount of torque required to elevate the trailer hitch and jack the trailer off the car floor. The hitch, manufactured by American Car and Foundry Division of ACF Industries Incorporated, is a tiedown and cushioning unit for semi-truck trailers on flat car (Piggy-back) use. Although speeds are low, loads are as high as 20,000 lbs. per bearing. Grease relubrication when desired is applied through the shaft to the inner race of the bearing.



"Trouble-free" performance of automatic pinsetter called for Sealed GUIDEROL bearings

Prelubricated and Sealed GUIDEROL bearings are used in two applications in BRUNSWICK AUTOMATIC PINSETTERS; on the Rake Crank Lever Assembly and on the Jogger Arm Assembly. The photo shows the location of the sealed GUIDEROL Rake Crank Lever application in the "mechanical brain" of the machine. The sealed GUIDEROL bearings help keep the "brain" highly efficient, with a minimum of maintenance. In the Rake Crank they are not relubricated and operate indefinitely on retained lubricant. Effective seals keep out dirt and foreign matter.

New mower design takes high cutting loads on Sealed GUIDEROL bearings



These unusual field mowers manufactured by Kosch Mfg. Co. use two seven foot cutting bars for a 14 foot cut with one tractor. The second bar depends on a ⅞" sealed GUIDEROL bearing to carry up to 7000 pound loads produced in the connecting drive for the reciprocating knife. Earlier sleeve and lower quality needle bearings were discarded for sealed GUIDEROL bearings that have prevented costly field breakdowns.

engineered electrical products

McGILL®

precision needle roller bearings

SEND FOR CATALOG No. 52-A

MULTIROL — GUIDEROL — CAMROL

McGILL MANUFACTURING COMPANY, INC., BEARING DIV., 200 N. LAFAYETTE ST., VALPARAISO, INDIANA

Circle 572 on Page 19

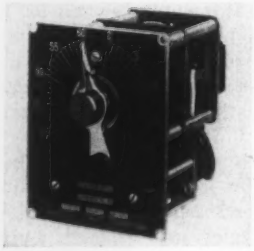
ings with bronze bearings. Both have four-bolt bases and 40-deg angular joints. They are adapted to applications involving heavy angular loads and to those where removable caps are required. **Link-Belt Co.**, Prudential Plaza, Chicago 1, Ill. I

Circle 789 on Page 19

Interval Timer

in timing ranges from 1 sec to 3 hr

Panel-mounting Series PAF interval timer, started from a momentary pulse, has load rating of 15 amp, rated at 115 v, 60 cycles, noninductive. It automatically resets at end of preset time cycle. Reset time is less than 0.02 sec over complete time scale, regardless of time cycle. Twelve models are available with over-all time cycles from 1 sec, with



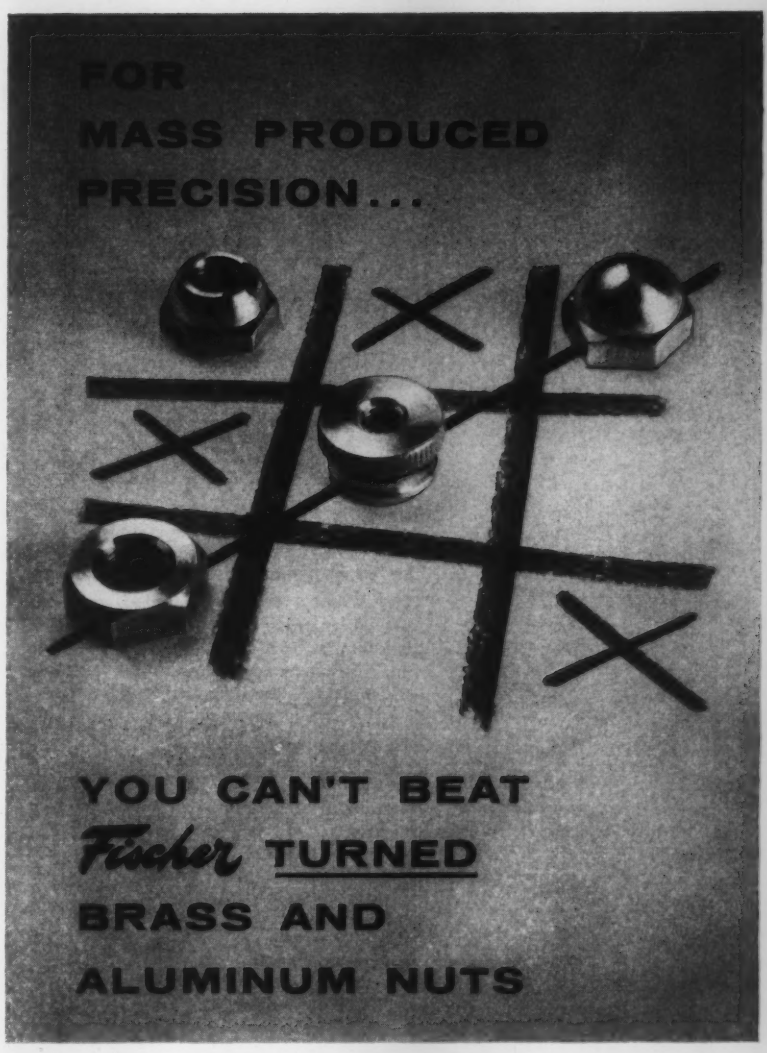
minimum setting of 1/60 sec, to unit with over-all time cycle of 3 hr and minimum setting of 3 min. Repeat accuracy is ±3 to 5 millisec over complete 1-sec scale. Unit is available in 115 and 230 v, 25, 50, 60, and 400 cycles. **Industrial Timer Corp.**, 1407 McCarter Highway, Newark 4, N. J. D

Circle 790 on Page 19

Hydraulic Cylinders

in cushioned or noncushioned types

Hydraulic cylinders are available in 1500 and 3000 psi rating in sizes from 1½ through 5-in. bore diam. Both double and single-acting styles are offered, with stroke length to specifications. Cylinders are either noncushioned or cushioned, cushions being either fixed or adjustable. Fast-return ball check is available with adjustable cushions. Tapered cups mounted on each side of piston provide cushioning by



In the game of tick-tack-toe, the right *second move* is very important. It can pre-determine the winner.

The same principle applies in purchasing precision nuts. *First:* decide the type and size of nut required. *Second:* specify the recognized source for quality, delivery and price . . . Fischer Special Mfg. Co.

As the leading producer of "turned" nuts, Fischer supplies standard, special and miniature nuts to exact customer specifications. Fischer nuts, mass produced by unique automatic machines, cost no more than those made by less precise methods . . . but their uniform accuracy assures fewer problems and new savings in fastening and assembly operations. *That makes you the winner!*

FOR DETAILS AND SPECIFICATIONS
SEND FOR CATALOG FS-1000.

there's no premium for precision at

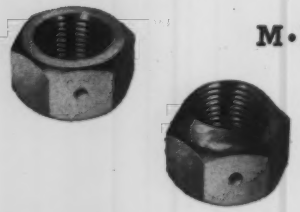
Fischer SPECIAL MFG. CO.

451 MORGAN STREET • CINCINNATI 6, OHIO

Circle 573 on Page 19

M·F "off the shelf"

line of lock nuts and weld nuts in all sizes NOW INCLUDES the AMAZING MF Whiz-lock



M·F TWO-WAY® LOCK NUT

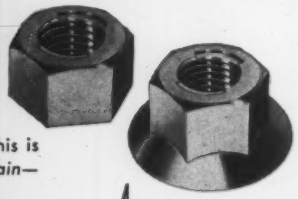
for faster application with consistent torque

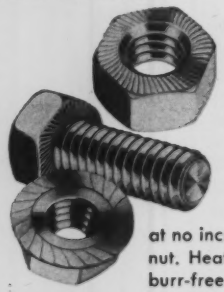
This all-metal double chamfered, re-usable prevailing torque lock nut can be applied to bolt threads from either end. The center locking principle permits bolt end to be flush with top of nut. Can be reapplied up to 10 times.

M·F UNI-TORQUE® LOCK NUT

for high torque consistency in full and jam thickness

This *prevailing-torque* lock nut will withstand terrific vibration and shock loading; retains its locking ability for as many as 10 RE-applications. This is the lock nut that enables you to predict—*and maintain*—UNIFORM bolt tension.





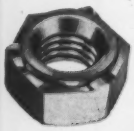
The amazing Whiz-Lock . . . based on an entirely new concept, delivers *MORE* locking power, *MORE* bolt tension with *LESS* torque. Locks onto the work, *close* to the hole. *COSTS NO MORE!* This revolutionary design can be produced on our special machines at no increased cost. A far superior lock nut. Heat treated, high tensile strength, burr-free—very high re-usability.

NEW!
THE M·F *Whiz-lock*
free spinning—handles like a common nut!

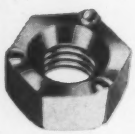
M·F PROJECTION WELD NUT

for low cost assembly

Solve production delays, cut manufacturing costs—fuse nut to the product in exact location. Engineered for assembly simplification. Available with the patented M-F Two-Way locking feature.



Pilot type



Recessed type

BROCHURES AVAILABLE:
The M-F Products Catalog—valuable data on torque and bolt tension. The Whiz-Lock Brochure.

patents pending

MACLEAN-FOGG LOCK NUT CO
5535 North Wolcott Avenue
Chicago 40, ED 4-8420

Offices in Principal Cities

Circle 574 on Page 19

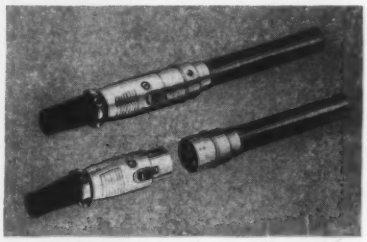
passing over cylinder ports to restrict exit flow of fluid. This gradually increases back pressure against piston, causing rapid deceleration of motion to absorb shock at end of piston travel. Options are offered in port thread sizes and types, and extensions, types of mountings, and port location. **Lanseair Development Corp.**, 8 N. Main St., Clintonville, Wis. K

Circle 791 on Page 19

Magnetic Switch

is contained in plastic shell

MH-2-P magnetic switch for industrial application is easy to mount in areas of limited access, and features a quick-disconnect plug. By eliminating elbow-type construction, unit is adaptable to many other applications. Plastic housing provides for less magnetic flux and increased sensitivity. Thus, smaller magnets can be used, and minimum magnetic-field transient time of only 8 millisec is needed to activate switch. **Electronic Products Div., Post Machinery Co.**, 175 Eliot St., Beverly, Mass. B



Circle 792 on Page 19

Miniature Potentiometer

has ¾-in. diam

Model 75 precision wound, ¾-in. diam potentiometer has all-aluminum housing for lightness. It can be ganged three to a common shaft. Other specifications include thickness of 0.35 in. from mounting surface, weight of 12 grams, and power

Does your new design call for a special alloy?

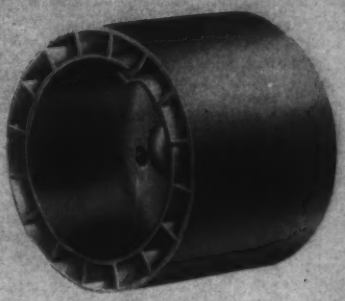
...ask Arwood about investment casting

When you design your new part for investment casting, you neatly sidestep that age-old designer's dilemma: part performance versus ease of production.

If the best alloy for the application is a machinist's nightmare, specify it and let Arwood worry about it. It won't bother us; our four foundries cast everything from magnesium and aluminum to cobalt-base and nickel-base alloys and stainless steel.

Arwood's complete service from blueprint to finished investment casting frees your hands to design for function and end use. Arwood will give you the shape you need, the alloy you need, and the quantities you need, from a few hundred to many thousands.

Write today for your free copy of the new 44-page Arwood "Practical Guide to Investment Casting". It provides all the information you need to evaluate the technique and use it to help solve your design problems.



magnesium

cobalt alloy

stainless steel

MACHINE THE SIMPLE...CAST THE COMPLEX

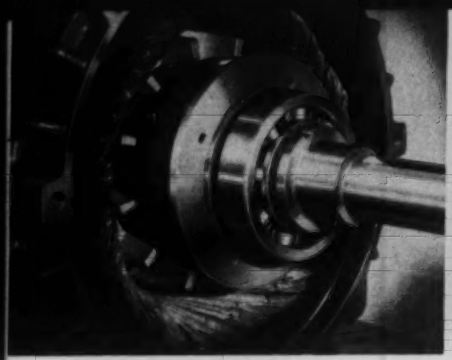
arwood

ARWOOD PRECISION CASTING CORP., 315 W. 44th St., N.Y. 36, N.Y.

A complete service from design through tooling, production and finish machining. Sixty-two engineering consultants from coast to coast.

PLANTS IN BROOKLYN, N. Y.; TILTON, N. H.; GROTON, CONN. & LOS ANGELES, CALIF.

Circle 575 on Page 19



HEAVY DUTY BALL BEARINGS . . . The ball bearings used in these motors are of the highest quality, with more than ample capacity to provide long trouble-free service under heavy loads.

BEARINGS CAN BE RELUBRICATED . . . Original factory lubrication will last for years in normal service—but convenient grease plugs are provided to permit relubrication that adds to motor life under severe conditions.

SECURELY SEALED FOR LOW MAINTENANCE . . . Both ends of these motors have running shaft seals to keep the bearings clean. Bearing housings are effectively sealed to prevent escape of grease.

Wagner Totally Enclosed Motors

Designed to give you Extra Protection

PROTECTED AGAINST CORROSIVE... ABRASIVE AND EXPLOSIVE ELEMENTS

WM59-7

Here are motors that will deliver full-rated horsepower under the toughest service conditions—that will help you keep your production rates up, and give you the kind of dependable, continuous operation that is so important to automation.

Type EP Motors are fully protected against damage from corrosion, dust, abrasives, fumes, steel chips or filings. Type JP is explosion proof as well—is designed and approved for use in explosive atmospheres.

Integral ratings, 1 through 100 horsepower, are built in the latest NEMA frames, 182 through 445 US, with ribs that add mechanical strength and increase the surface cooling area.

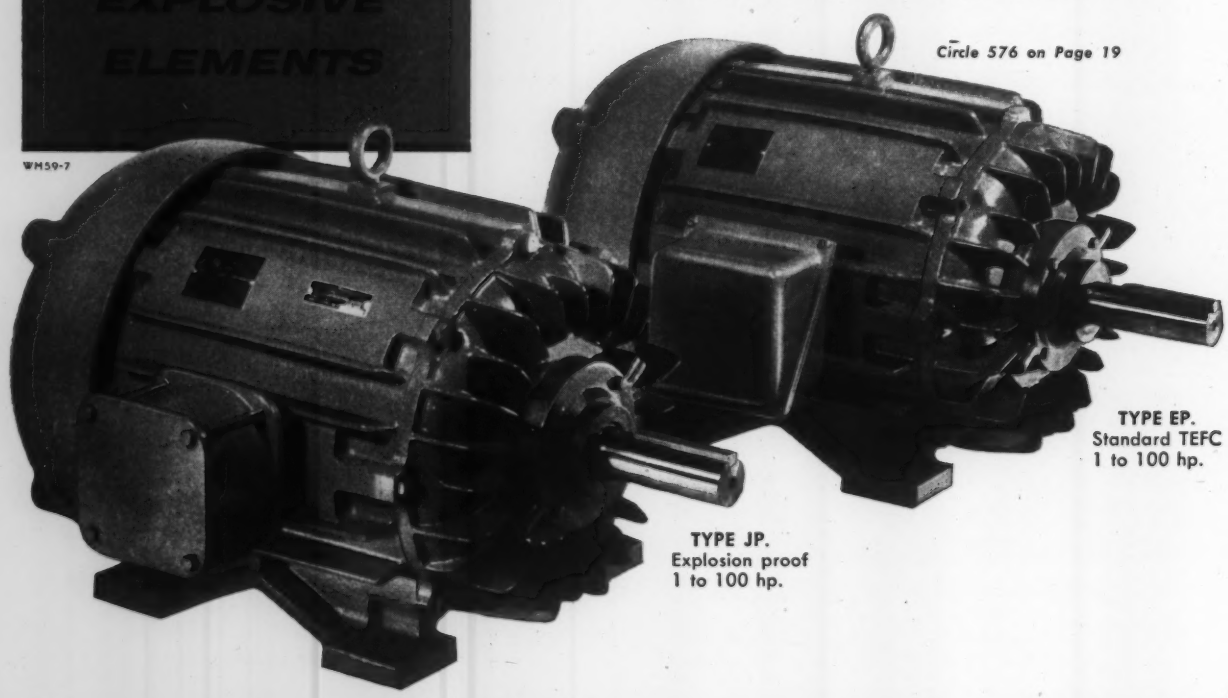
Let your Wagner Sales Engineer show you how these protected motors can bring you savings on initial motor costs, maintenance costs, and in continuity of operation.

Branches and Distributors in All Principal Cities

Wagner Electric Corporation

6404 Plymouth Ave. • St. Louis 14, Missouri

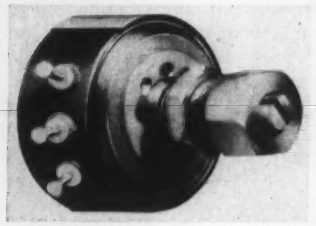
Circle 576 on Page 19



TYPE EP.
Standard TEFC
1 to 100 hp.

TYPE JP.
Explosion proof
1 to 100 hp.

OTHER FRAME SIZES AVAILABLE IN RATINGS THROUGH 500 HP.



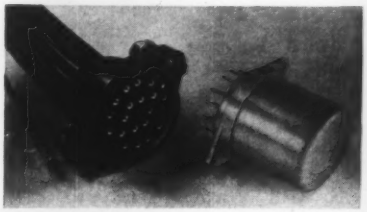
rating of 1.5 w at 25 C. Electrical rotation is 349 deg, or unit is supplied with stop to limit travel. Resistance range is 10 to 100,000 ohms. **Handley Inc.**, 2030 Colorado Ave., Santa Monica, Calif. L

Circle 793 on Page 19

Component Receptacles

use crimp-type, snap-locked contacts

Receptacles utilizing crimp-type, snap-locked contacts for use with plug-in relays and other plug-in components are available. Closed-entry sockets are crimped to wire ends and snap locked into relay receptacle. Only as many sockets as are required need be inserted into receptacle, and they can be removed readily for circuit changes, providing a high degree of versatility. Receptacles and contacts meet or ex-



ceed military specifications for voltage drop, dielectric strength, contact engaging and retention forces, corrosion resistance, and mechanical strength. They also resist shock and vibration. **Omaton Div., Burndy Corp.**, Norwalk, Conn. B

Circle 794 on Page 19

Adjustable-Speed Sheave

for use with standard V-belts

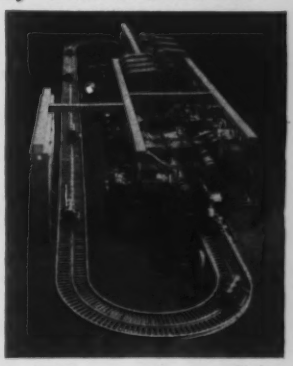
Simple, accurate speed adjustment and nonfreezing construction are features of SVS multiple-groove, adjustable-speed sheave for use with V-belts of A, B, C, or D-section. Positive-locking action prevents mo-

STEEL *from Wheelock, Lovejoy* BULLETIN

W-L DETROIT For the first time, HY-TEN D-2 air hardening steel now available here in rounds, squares, flats and billets. Also a fine stock of standard alloy grades, especially A-8620, as well as all HY-TEN grades. Excellent service from our new warehouse.

W-L CHICAGO Steady demand for "B" No. 3X for flame-hardened parts such as boring bars. Good stocks of HY-TEN AIS—the best carburizing alloy steel, and freest machining available today—a new W-L exclusive!

W-L CINCINNATI This 23-station Avey Line-O-Dex transfer machine, designed and built by The Avey Division of Motch & Merryweather Machinery Co., Cincinnati, Ohio, is equipped with spindles made of our HY-TEN "B" No. 2. This grade was chosen for its great tensile strength (100,000 P. S. I. in the natural condition), toughness, and fine wearing qualities.



W-L CAMBRIDGE We are now distributing FLEXANGLE, the easy-to-erect structure assembly for all types of racks, shelves, platforms, etc. It's completely universal and low in cost—can be used anywhere, by anyone, for any storage purpose.

W-L HILLSIDE Our stock of flat and square sizes in HY-TEN M Temper Oil Hardening Steel can save you time and money in your tooling program. HY-TEN "B" No. 3X pre-heat treated in rounds, squares and flats available in a wide range of sizes. Billets on hand for hammer forging in all grades of HY-TEN.

W-L CLEVELAND Excellent stock of brake die flats and squares. Also many sizes up to 16" x 18" in HY-TEN Mold Steel. Excellent deliveries.

W-L BUFFALO A wide range of rounds and hexagons in cold drawn AISI leaded and non-leaded A-4140. Also many sizes of the new "B" No. 3X-40 in rounds and hexagons.

Write our Cambridge office today for your *free* Wheelock, Lovejoy Data Sheets. They'll give you complete technical information on grades, applications, physical properties, tests, heat treating, etc.

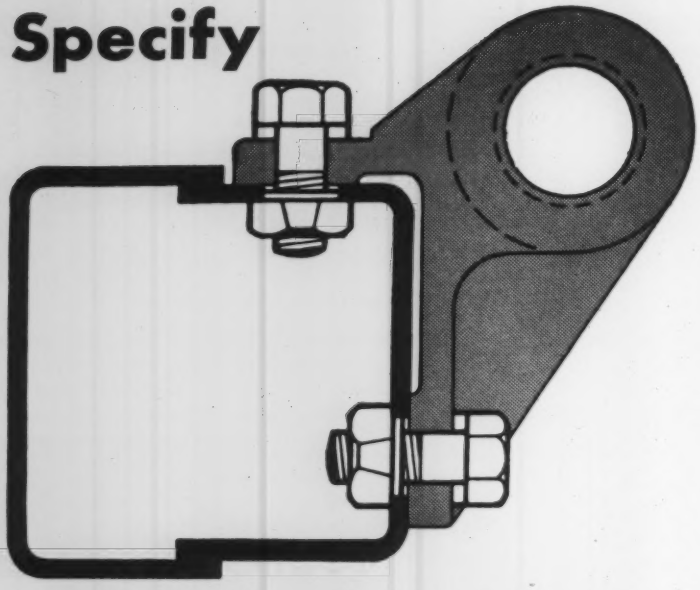
WHEELOCK, LOVEJOY & COMPANY, INC.
134 Sidney Street, Cambridge 39, Mass.

AMERICAN STEEL WAREHOUSE ASS'N

AGENTS: Southern Engineering Company, Charlotte, N. C.; Sanderson-Newbould, Ltd., Montreal & Toronto

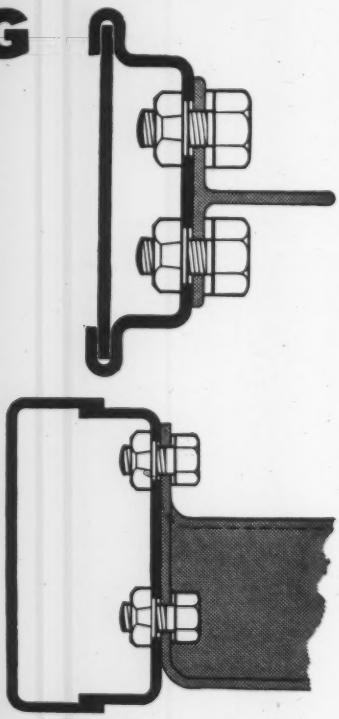
Circle 577 on Page 19

Specify



MIDLAND

WELDING NUTS for those hard-to-reach spots!



On the lookout for ways to cut costs and save time? Write for free booklet, "Save With Midland Welding Nuts."

MIDLAND-ROSS CORPORATION

OWOSSO DIVISION • OWOSSO, MICHIGAN

MIDLAND WELD NUT

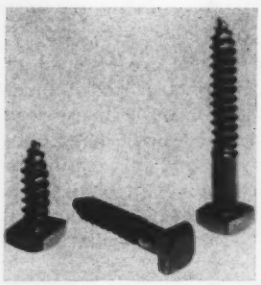
Circle 578 on Page 19

tion between components, and there is no need for lubrication. Absence of wear and corrosion eliminates freezing. Positive-locking collars securely clamp split-flange extensions to a sleeve keyed to shaft on which sheave is mounted. Clamping screws on collars are tightened to secure sheave on motor shaft and to lock all moving sheave parts. Design of locking collars prevents overtightening of clamping screws. Sheave is for use with two, three, or four-groove standard-stock companion sheaves. Range of capacity is from 5 to 150 hp. **T. B. Wood's Sons Co.**, 1200 Fifth Ave., Chambersburg, Pa. E

Circle 795 on Page 19

Lag Bolts

range in diameter from ¼ to ¾ in.



Approximately 100 sizes of lag bolts, available from stock, range in diameter from ¼ to ¾ in. with lengths to 12 in. All sizes are provided with gimlet point and full-size shank. **Standard Screw Co.**, Dept. CR, 2701 Washington Blvd., Bellwood, Ill. J

Circle 796 on Page 19

Silicon Rectifiers

are plug-in types for temperatures to 165 C

Instant operation, ability to function at high temperatures, rugged, shatterproof housing, and long life are advantages offered by plug-in silicon rectifiers designed to match electrical ratings of many standard vacuum-tube rectifiers. Seven types cover current ratings from 85 to 600 ma and peak-inverse-voltage ratings from 1500 to 2800 v. All types are hermetically sealed, and exhibit maximum stability in all mounting positions. Temperature

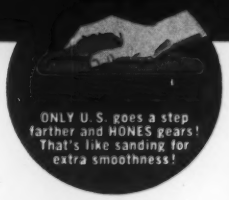
Now U.S. hones gears to superfinish

for:

SMOOTHNESS
QUIET RUNNING
LONGER LIFE

HOBBING gears is like SAWING WOOD. All gears are hobbed.

SHAVING gears is like PLANING. Some makers shave gears.



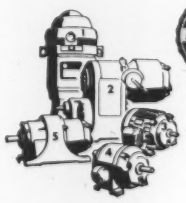
ONLY U.S. goes a step farther and HONES gears! That's like sanding for extra smoothness!

another reason to specify:

U.S. Syncrogear Motors

Among the makers of electric gearmotors, only one – U.S. Motors – *hones* gears to assure extremely accurate profile and smoothness. This honing means quiet running and longer life. Gear hobbing, the necessary first step in cutting gear teeth, leaves a degree of roughness analogous to sawing wood. Many gear makers go no further. Some, however, shave the gear teeth before hardening. This leaves a surface analogous to planing wood.

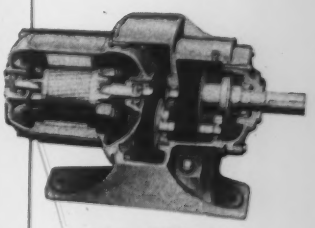
The ultimate refinement in tooth profiling, however, is honing – which may be likened to sanding of wood. This takes place *after* gear teeth are hardened. Thus, it takes out any imperfections and minor heat-treat distortions. It is to assure precision and exclusive refinements such as this that U.S. makes its own gears. Another good reason to specify: "U. S. SYNCROGEAR MOTORS." (⅓ to 50 H.P.)



U.S. ELECTRICAL MOTORS INC.

P. O. BOX 2058
LOS ANGELES 54, CALIFORNIA
OR MILFORD, CONNECTICUT

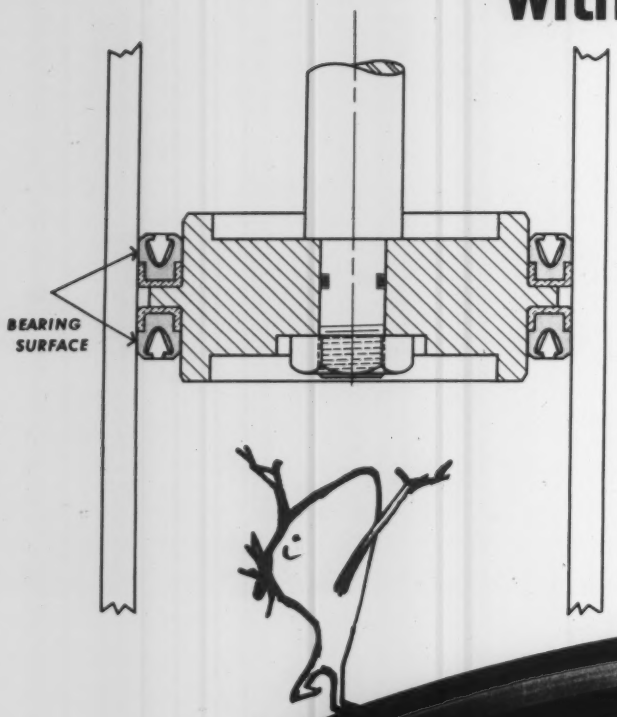
U.S. MAJOR MOTOR LINES INCLUDE:
1. Vertical Solid & Holloshaft, 2. Varidrive, 3. Totally-Enclosed, 4. Uniclosed, 5. Syncrogear. Also, many other special motors.



SEND FOR FREE SYNCROGEAR MOTOR BROCHURE No. F-1880, *explaining the Syncrogear principle. Color illustrated.*

Circle 579 on Page 19

Squeeze down on expensive U-Packing Assemblies . . . with IPC's revolutionary "GUIDE-U-PAK"*. . . the packing with a built-in bearing!



A new engineering concept for hydraulic systems sealing! . . . IPC's GUIDE-U-PAK is a bonded case U packing that really puts the squeeze on expensive, complex U packing assemblies. Follower plates or back up plates with their high cost drilling, machining and fitting are eliminated. *Moreover*, GUIDE-U-PAK supplies its own bearing . . . riding smoothly on a close tolerance brass**case. You can end the practice of machining a wear sleeve on the piston surface, too! GUIDE-U-PAK is press fitted on the piston.

The "custom approach" in packings and seal manufacture, which typifies all IPC products, has brought this development through extensive testing. Precise manufacture means that you can specify critical tolerances for both ID and OD measurements or we will be glad to analyze your problem . . . recommend specific sizes. By establishing these limitations you can be assured of exact bearing surface and press fit.

For your next hydraulic sealing problem investigate GUIDE-U-PAK. You'll be pleasantly surprised!

OIL SEALS / PACKINGS / PRECISION MOLDING

Custom designed for your application . . .

IPC

*PATENT PENDING

**Other materials are available. Write for details.

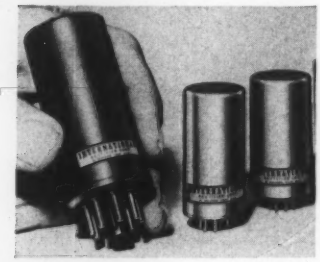
INTERNATIONAL PACKINGS CORPORATION

Bristol, New Hampshire

© IPC

P-6

Circle 580 on Page 19



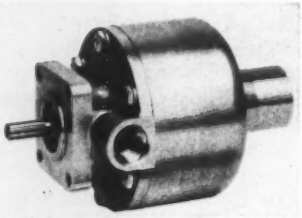
range is from −65 to +165 C. **International Rectifier Corp.**, 1521 E. Grand Ave., El Segundo, Calif. L

Circle 797 on Page 19

Fuel Pumps

have excellent resistance to contamination

Fixed-displacement, vane-type fuel pumps for jet engines are designed for 1000 hr service life. Fuel flow rates at pressures to 1500 psi range from 400 to 50,000 lb per hr at up to 6000 rpm pump speed. Some models are capable of speeds to 20,000 rpm and operating at pressures exceeding 1500 psi. All pumping parts are contained in a replaceable cartridge providing design flexibility and simplified maintenance.



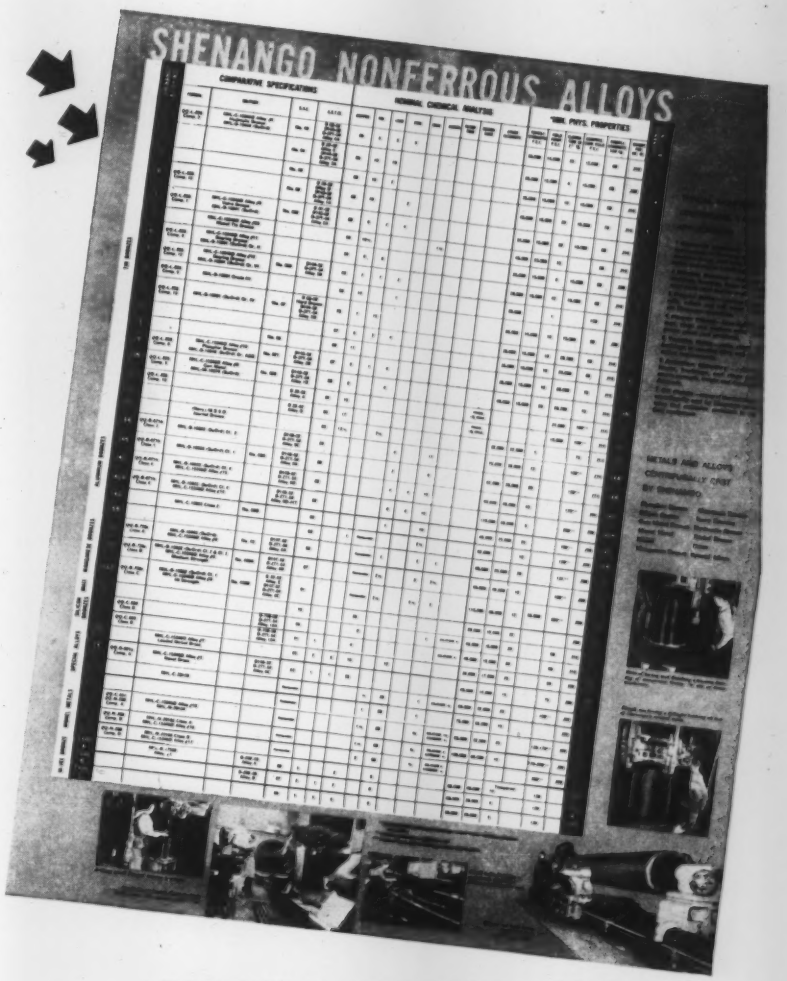
Pumps meet specifications MIL-E-5009B and MIL-E-8595B for contamination tolerance. **Vickers Inc., Div., Sperry-Rand Corp.**, Detroit 32, Mich. H

Circle 798 on Page 19

Overtemperature Relay

for use in a variety of ac applications

Direct-monitoring, overtemperature-relay device consists of magnetic relay, two transistor amplifiers, diode network for signal separation, and voltage-regulated power supply. Designed to protect three-phase ac motors, relay is suitable for use wherever overtemperature is a problem. Design permits maximum use of



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for ***COMPARATIVE SPECIFICATIONS***
CHEMICAL ANALYSES
MINIMUM PHYSICAL PROPERTIES

...clearly charted in SHENANGO'S new Bulletin No. 157

This invaluable chart of nonferrous alloys centrifugally cast by Shenango is readily available upon request. For your free copy, write to this publication or the Centrifugally Cast Products Division, The Shenango Furnace Company, Dover, Ohio.

SHENANGO CENTRIFUGAL CASTINGS

COPPER, TIN, LEAD, ZINC BRONZES · ALUMINUM AND MANGANESE BRONZES
MONEL METAL · NI-RESIST · MEEHANITE METAL · ALLOY IRONS · DUCTILE IRON

Circle 581 on Page 19

I'm being courted again...

You'd have thought Herbert actually had to handle those dirty old gears himself the way he'd come home cursing and mumbling about "rejects" and "added costs". But this is the third night this week he's taken me out for dinner! I'd certainly like to meet that CINCINNATI person!

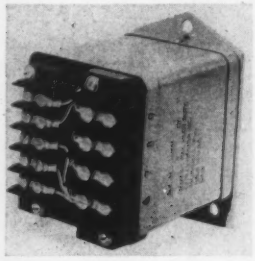
Whether it's custom gears or custom gear boxes, you'll be pleased with CINCINNATI quality, price and delivery. Shaved gears to 39" diameter, tooth grinding capacity to 25". Write for brochure.

CINTI®

THE CINCINNATI GEAR CO.

Wooster Pike and Mariemont Ave. Cincinnati 27, Ohio
Custom Gear Makers Since 1907

GEARS, good gears only



equipment without danger of overheating, since component responds only to actual temperature of protected equipment. Power-supply ratings are 110, 208/220, 440, or 550 v, 60 cycles. **Cutler-Hammer Inc.**, 328 N. 12th St., Milwaukee, Wis. K

Circle 799 on Page 19

Neoprene Coating

provides chemical and abrasion resistance

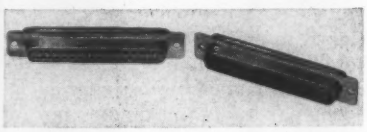
General - purpose, one-part, neoprene-rubber-based coating, Coro-Gard 1706, provides excellent chemical, abrasion, and weathering resistance for the protection of metal, wood, concrete, cloth, and some plastics. It has high adhesion to unprimed steel, aluminum, copper, galvanized steel, concrete, wood, and glass-fiber-reinforced polyester plastics. Coating air-cures to a tough, rubbery film that has good resistance to corrosive action of chemicals and fluids. It also protects against abrasion and erosion caused by flow of liquids containing silt and sand. Coating remains flexible and strong even under varying weather conditions. It can be applied to surfaces without special primer. **Adhesives and Coatings Div., Minnesota Mining & Mfg. Co.**, 900 Bush Ave., St. Paul 6, Minn. J

Circle 800 on Page 19

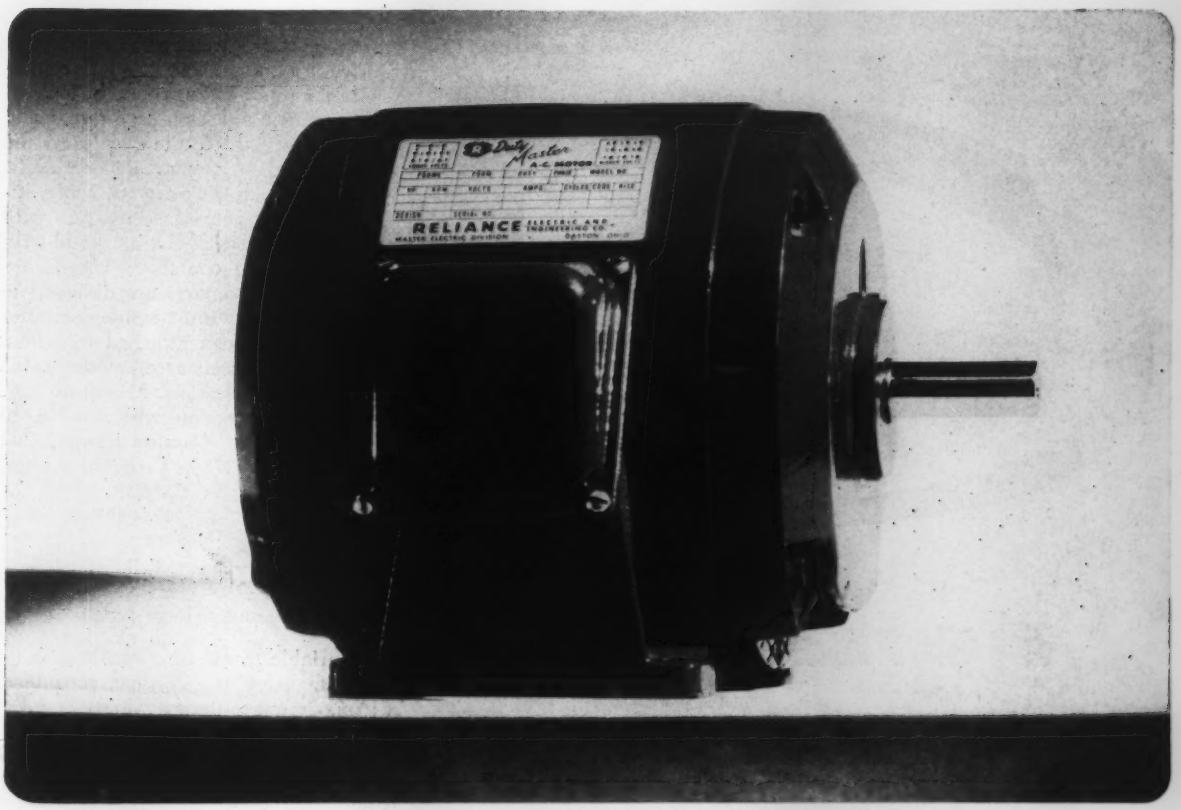
Subminiature Plugs

four styles have monobloc insulators

Golden - D subminiature plugs, available for critical applications,



Circle 582 on Page 19



DUTY MASTER

a brand new a-c. motor

Product of Reliance Electric and Engineering Company and its Master Electric Division, Duty Master's new design gives users better protection from the inside out, simplified lubrication, better response and improved all around performance. The Duty Master line, from protected open, to totally enclosed, explosion-proof, 1 to 250 hp., is ready for delivery *NOW*.

Duty Master's insulation, by means of a series of multiple dips and bakes in thermosetting varnish plus final protection in finishing enamel, makes it resistant to water, acid, dirt and other contaminating elements . . . adds years to motor life.

"Metermatic" lubrication regulates flow of grease to the bearing—provides automatic grease relief. No danger of over-or under-lubrication . . . no maintenance headaches.

Duty Master's low inertia rotor has faster response in starting, stopping and reversing. This, plus better ventilation and increased accelerating torques, permits frequent starts and stops without over-heating.

Duty Master's new design proves conclusively that all a-c. motors are *not* alike . . . that this new motor gives users the best value in industry today.

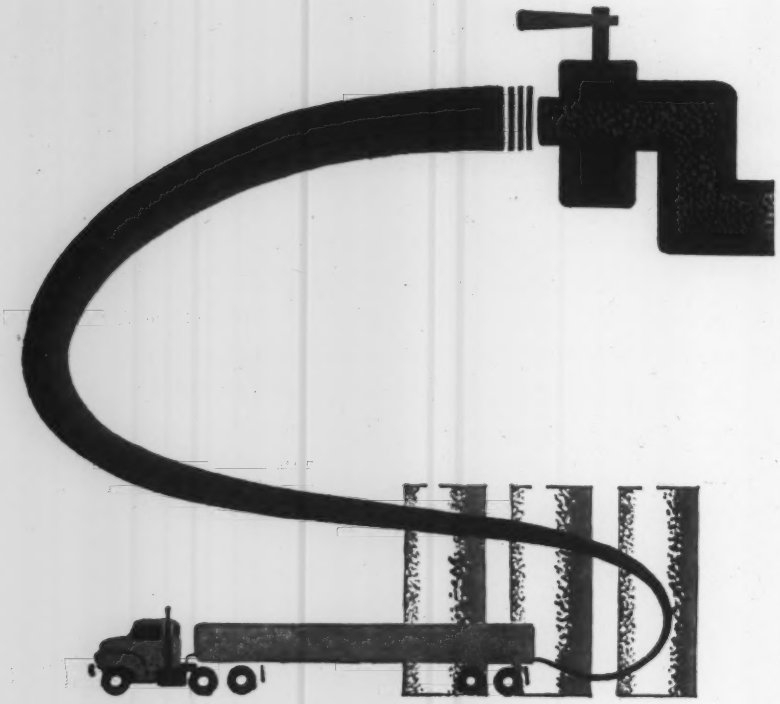
Call your Reliance Sales Engineer or distributor—listed in the Yellow Pages—for the complete story, or write for Bulletin No. B-2106, Reliance Electric and Engineering Company, 24701 Euclid Avenue, Cleveland 17, Ohio.

B-1636

RELIANCE ELECTRIC AND ENGINEERING CO.

DEPT. 2811A CLEVELAND 17, OHIO
CANADIAN DIVISION: TORONTO, ONTARIO
Sales Offices and Distributors in Principal Cities

MASTER REEVES R

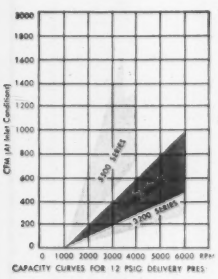


NEW M-D GEARED P.T.O. BLOWERS . . . NO BELTS-NO PULLEYS

for tractor mounted conveyor systems

Now a compact, 3-lobe M-D blower fits *inside* tractor frame . . . weighs only 165 lbs. Geared-in-head blower (2 to 1 or 2½ to 1 ratios) connects directly to truck P.T.O.—no belts or pulleys—develops 15 PSIG continuous air flow or up to 18 PSIG in surges.

M-D blowers operate at wider pressure and speed ranges than any other rotary positive blower. Capacities of 22 production models range from 50 to 4,000 CFM, pressures to 15 PSIG single, 70 PSIG multi-stage.



For full information write

M-D BLOWERS, INC.

RACINE, WISCONSIN

A SUBSIDIARY OF MIEHLE-GOSS-DEXTER, INC.

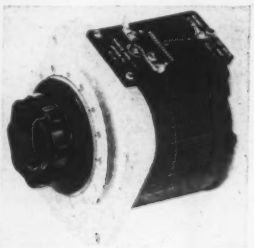
feature monobloc insulator, test-probe-proof socket contacts, low engagement and separation forces, and finish of gold Iridite over cadmium plate. Four styles include units with miniature contacts, with ungrounded coaxial contacts, with grounded coaxial contacts, and with high-voltage contacts. Ungrounded coaxial contacts are designed to be snapped into insulators after they have been attached to cables. Coaxial contacts accommodate wide range of cable sizes. Miniature contacts accommodate wire size No. 20 and smaller. **Cannon Electric Co.**, P. O. Box 3765, Terminal Annex, Los Angeles 54, Calif. L

Circle 801 on Page 19

Variable Transformers

are nonovervoltage types

Variable transformers without overvoltage feature, N type, provide at maximum settings a voltage equal to line voltage, in contrast to overvoltage types which provide maximum voltages about 17 per cent above line voltage. Transformers can be supplied cased, or in tandem assemblies where no more than line voltage, but greater current output, is desired. **Ohmite Mfg. Co.**, 3650 Howard St., Skokie, Ill. J



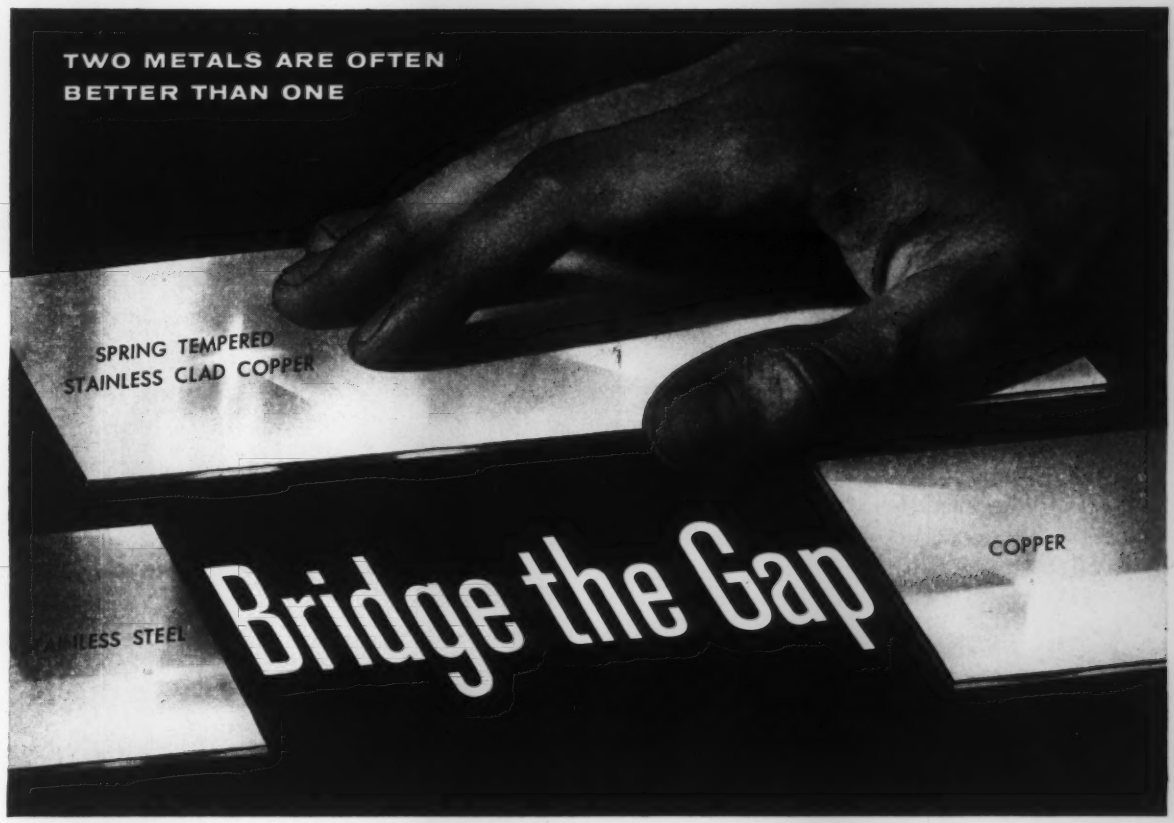
Circle 802 on Page 19

Synthetic Oil

for hydraulic operations at temperatures to 350 F

Anderol L-386 is a medium-viscosity synthetic diester with operating temperature range of −65 to 350 F. Nongumming, completely compatible with ordinary lubricants, and having low shear characteristics, oil is suggested for use in hydraulic and pneumatic systems, machine tools, radar systems, and precision instruments. Lubricant has

Circle 583 on Page 19



... *between the Limitations of Single Metals with* GENERAL PLATE CLAD METALS

The performance of a single metal will go so far . . . *but frequently not far enough.* And to bridge the gap between the limitations of single metals and the desired results, clad metals are used to obtain the requirements, or to do the job better . . . often at lower cost. That's why manufacturers of all types of products turn to General Plate for recommendations on their metal requirements. For instance . . . for electrical spring manufacturers, General Plate has developed:

Bronco*, phosphor bronze double-clad on copper to provide higher electrical conductivity without increasing cross-sectional area of spring blades.

Conflex* hardenable steel clad on one or both sides with sheet copper to obtain a superior spring material with better electrical conductivity and greater strength — at lower cost — than comparable copper alloys. And the copper surface is excellent for electroplated finishes.

Spring Tempered Stainless Clad Copper for spring blade service in applications requiring high electrical conductivity and excellent resistance to various types of corrosion.

If you are seeking metals with useful characteristics that can't be found in a single metal or alloy, investigate clad metals. If you want stronger or lighter components — or better electrical and mechanical properties — or fewer corrosion problems — or if you are interested in conserving critical metals or reducing parts costs, you can profit by using General Plate Clad Metals.

Write for a General Plate catalog today. Or better yet, why not talk over your requirements with a competent field engineer. His knowledge of the applications of clad metals is yours for the asking. No obligation, of course.

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Circle 584 on Page 19

600° to 1000°F.

HIGH STRENGTH AND STABILITY

WITH GOOD FABRICATION PROPERTIES

AM 350 and AM 355 are metals for the space age! The combination of easy fabrication with high strength-to-weight ratio of AM 350 and AM 355 interests missile and supersonic aircraft designers with problems of high strength at elevated temperatures.

This pair of precipitation hardening stainless steels from Allegheny Ludlum research are easy to fabricate in the annealed condition. They can be spun, drawn, formed, machined, brazed and welded using normal stainless procedures.

Both alloys have high strength without embrittlement from room temperature to 1000°F, plus good ductility at elevated temperatures. They have remarkable stability and excellent corrosion resistance.

AM 350 is available in sheet, strip, foil, small bars and wire. AM 355, best suited for heavier sections, is available in forgings, forging billets, plates, bars, wire, sheet and strip.

For further information, see your A-L sales engineer or write for the new technical booklet, "AM 350 and AM 355," **Allegheny Ludlum Steel Corporation, Oliver Building, Pittsburgh 22, Pa.**

ALLEGHENY LUDLUM

EVERY FORM OF STAINLESS . . . EVERY HELP IN USING IT

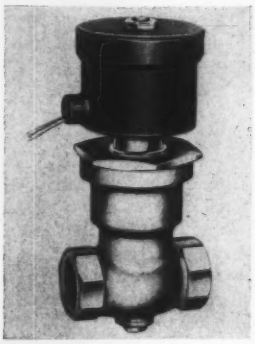
excellent viscosity-temperature relationship and evaporation rate of 5.1, so that it lasts up to 100 times longer than ordinary petroleum products. Additional properties include built-in rust protection and antifoam. Light film will protect working parts from humid and salt conditions at all temperatures. **Industrial Lubricant Div., Lehigh Chemical Co.**, Chestertown, Md. C

Circle 803 on Page 19

Solenoid Valve

for pressures to 3000 psi

Full-ported, direct-lift solenoid valve, Series 30,000, has port sizes from ¼ to 3 in. It meets demand for positive operation over entire range from 0 to 3000 psi. Available in



bronze or stainless steel, valve features Uramic solenoid which assures reliable operation regardless of line pressures. **Atkomatic Valve Co. Inc.**, 545 W. Abbott, Indianapolis, Ind. J

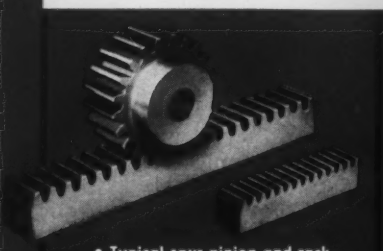
Circle 804 on Page 19

Speed Reducers

are equipped with C-flange motor mountings

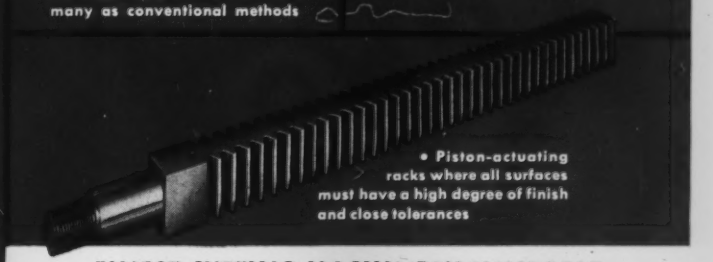
Fin and fan-cooled speed reducers, designated Hi-Line, are available with either of two types of C flanges. One style permits direct connection of motor shaft to reducer input shaft. Other style is equipped with a bell-shaped flange which allows sufficient room to accommodate a flexible motor coupling between drive motor and input shaft of reducer. Flanges accommodate standard NEMA motor frames. Reducers feature external fin and fan cooling to provide up to 80 per cent more capacity than compar-

NOW—PRECISION RACKS on a Commercial Price basis



• Typical spur pinion and rack. Short pieces as shown here can be cut two at a time with a single broach pass and not more than two passes. Longer racks require more cutting passes but not as many as conventional methods

• Heat treated alloy steel double racks 75″ long overall 2 D.P., 6″ face, for blast furnaces



• Piston-actuating racks where all surfaces must have a high degree of finish and close tolerances

FINEST CUTTING MACHINERY AVAILABLE

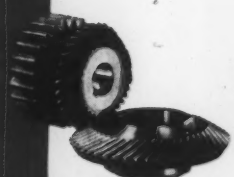
• Large surface grinder, 42″ dia. wheel, for grinding rack blanks 10″ x 17″ x 64″ long on all four sides within .002″ square, flat and parallel before tooth cutting

• Special precision, high production rack-cutting machine designed and built by BRAD FOOTE. Racks in illustration are used in precision glass-polishing machinery

RACKS
IN LARGE QUANTITIES
Spur or Helical Teeth
16 D.P. to 4″ Circular Pitch
Practically Any Shape of Blanks
Closer Tooth-Spacing Limits
Much Better Profile Finishes
Accurate Parallelism and Lead

• We also have conventional rack-cutting equipment and manufacture racks of all sizes and shapes in single piece lots and smaller quantities where production tooling would not be required.

BRAD FOOTE makes any type of gear and speed reducers, transmissions and intricate power units. All are famous for long, satisfactory service. Why not discuss your requirements with our engineering staff, let us make recommendations or quote on your specifications. It can cost you much more to settle for less than BRAD FOOTE quality and service.

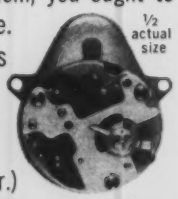


BRAD FOOTE GEAR WORKS, INC.
MEMBER OF AGMA
1311 South Cicero Avenue • Cicero 50, Illinois
Bishop 2-1070 • OLympic 2-7700
subsidiary • PITTSBURGH GEAR COMPANY, Neville Island · Pittsburgh 25, Pa., Phone SPaulding 1-4600

Circle 586 on Page 19

WHO NEEDS FEED-BACK ?

The patented chronometric governor of this standard DC Timing Motor is a tyrant: without any other circuitry, it holds the motor output speed within ±0.1% while driving charts, cams, contacts, actuators or other devices. It holds the rate even if output shaft load, line voltage, or ambient temperatures change. And that's just the standard model of this little gem: custom variations can do even better, under special conditions. **The A. W. Haydon Co. knows all about timers and timing.** If you have a specific timing problem, you ought to have our literature. Bulletin MO 802 is yours for the asking (5800 Series chronometrically governed DC Motor.)

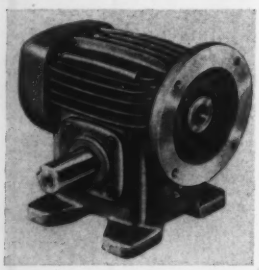


½ actual size

THE AWH HAYDON COMPANY

249 North Elm Street, Waterbury 20, Connecticut

Circle 587 on Page 19



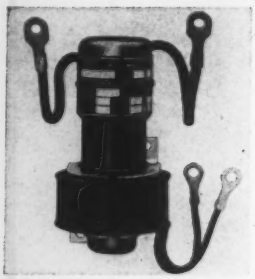
able nonventilated reducers. Reducers are available in sizes from 1.33 to 5.25 in. center distance. Horsepower ratings range from 1/16 to 18 hp. **Ohio Gear Co.**, 1400 E. 179th St., Cleveland 10, Ohio. F

Circle 805 on Page 19

Mercury Timer Relay

operates on half current of former models

Hydrogen Arc-Quenched mercury timer relay is a sensitive, small-sized unit which operates on approximately half the current of former models. It is available with normally open or normally closed contacts (mercury to mercury) and time delays on opening or closing



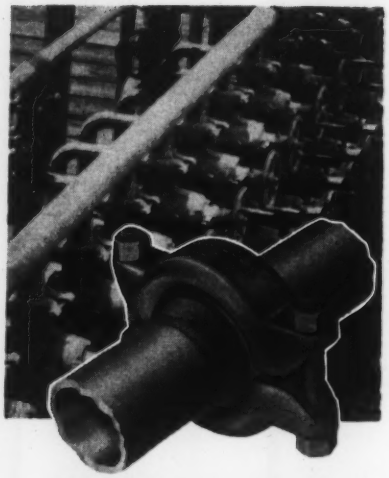
or both. Ac and dc models are furnished. **Durakool Inc.**, Elkhart, Ind. J

Circle 806 on Page 19

Rotating Components

in sizes 8, 10, 11, 15, 18

Standard gear heads, speed reducers, and speed increasers are available from stock in a variety of ratios in sizes 8, 10, 11, 15, and 18. They are designed for extreme reliability and transmit high torque in comparatively short over-all length. Units conform to applicable military specifications. They operate in temperatures from −55 to +150 C. Maxi-



GRAYLOC
Pipe Connections Make-Up In 3 Minutes

Unlike the 3-minute egg or the 3-minute car wash, GRAYLOC 4-inch Pipe Connections actually can be made up in 3 minutes by an unskilled laborer. What's more, the connection will test up to 10,000 p.s.i. every time. Two men can make-up a 24-inch connection in 15 minutes.

GRAYLOC, with its new principle in pipe make-up, can be broken out and re-made repeatedly with no wear or other damage to the connections and without replacement of the seal ring.

The GRAYLOC principle features flexible tapered lips of the seal which are angled slightly less than the mating hub. This forms a line seal which is changed to a surface seal as the connection comes together and the lips deflect. This design makes it possible for GRAYLOC to withstand full vacuum, high external pressure or extreme internal pressure.

GRAYLOC has practical applications in missile, chemical, petroleum, and atomic energy processes.

For additional information, write, wire or telephone Gray Tool Company.

GRAY Tool Company

P. O. BOX 2291 HOUSTON, TEXAS
REpublic 4-1641 5905

Circle 588 on Page 19

Count on *Continental* and collect the savings you plan with power driving tools

Fastener faults can quickly foul up the best plans and the finest equipment for high-speed assembly. Defective screws that might "get by" for hand driving can be disastrous to assembly with hopper-feed machines and other power driving equipment.

To get *all* the savings you properly expect from your tooling investment, count on Continental HOLTITE quality standards. Tolerances are matched to the toughest demands for uniformity in every detail. Special tests and trial runs under job conditions are made, as required, to assure trouble-free performance on the assembly line.

You can count on Continental, also, for cost-saving ideas in fastener selection. At your request, a Continental Assembly Specialist will make detailed recommendations.

Write or phone: Continental Screw Co., 461 Mt. Pleasant St., New Bedford, Mass.

CONTINENTAL
SCREW COMPANY, NEW BEDFORD, MASS.
HOLTITE FASTENERS

HY-PRO TOOL COMPANY . . . DIVISION
RESEARCH ENG. & MFG., INC. SUBSIDIARY

HOLTITE PHILLIPS AND SLOTTED HEAD
WOOD • MACHINE • TAPPING
THREAD CUTTING SCREWS
HANGER AND STOVE BOLTS
SEMS • NYLOK

HY-PRO PHILLIPS INSERT BITS AND HOLDERS

Announcing . . .

New Production Capacity

To Serve You Better

Large Generated Gears

SPUR—HERRINGBONE—HELICAL

for a wide range of industrial applications

Gears which must operate smoothly and without vibration at higher speeds and under greater loads must correspondingly be more accurate in tooth profile and spacing.

H & S Generated Gears provide these results.

To meet increasing customer demands, Horsburgh & Scott has broadened its manufacturing capacity and tooled to produce *large* Generated Gears up to 125" diameter.

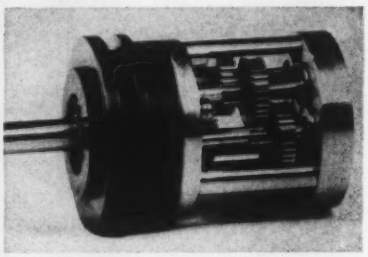
Offering the same high quality standards which characterize the complete H & S Gear line, production capacities for large Spur, Helical and Hobbed-Herringbone Gears are now available in the following dimensions:

Up to 80" outside diameter at 1 DP
Up to 90" outside diameter at 1¼ DP
Up to 100" outside diameter at 1½ DP
Up to 125" outside diameter at 2 DP

Face widths up to 42", depending on helix angle.

Take advantage of this new capacity, and our long experience as specialists in this field. Send your specifications, drawings or plans — or tell us about your power transmission problem. Our technical staff will promptly consider your requirements and render recommendations and quotations.

THE HORSBURGH & SCOTT CO.
GEARS AND SPEED REDUCERS
5112 Hamilton Avenue • Cleveland 14, Ohio



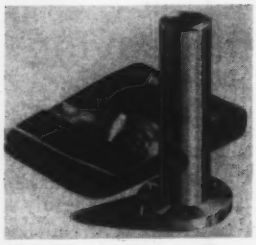
mum backlash at output shaft is 30 min in any ratio. Units use either sleeve or ABEC 7 ball bearings, and have preset mechanical slip clutch for overload protection. **Kinetic Instrument Corp.**, 1070 Linwood St., Brooklyn 8, N. Y. D

Circle 807 on Page 19

Latching G-Switch

is small, timed-action unit

No. 6UO-115 timed-action, latching g-switch is simple in design, the only moving part being a precision-ground steel ball held in place by a two-pole magnetic field. Small switch responds to acceleration forces from 1 to 40 g within a tolerance of ±5 per cent of setting. Time delays can be adjusted between 0.5 and 1.5 sec. When axial acceleration force exceeds pull of magnet, ball is released and moves to close normally open electrical contact. Unit meets all environmental specifications of MIL-E-5272,



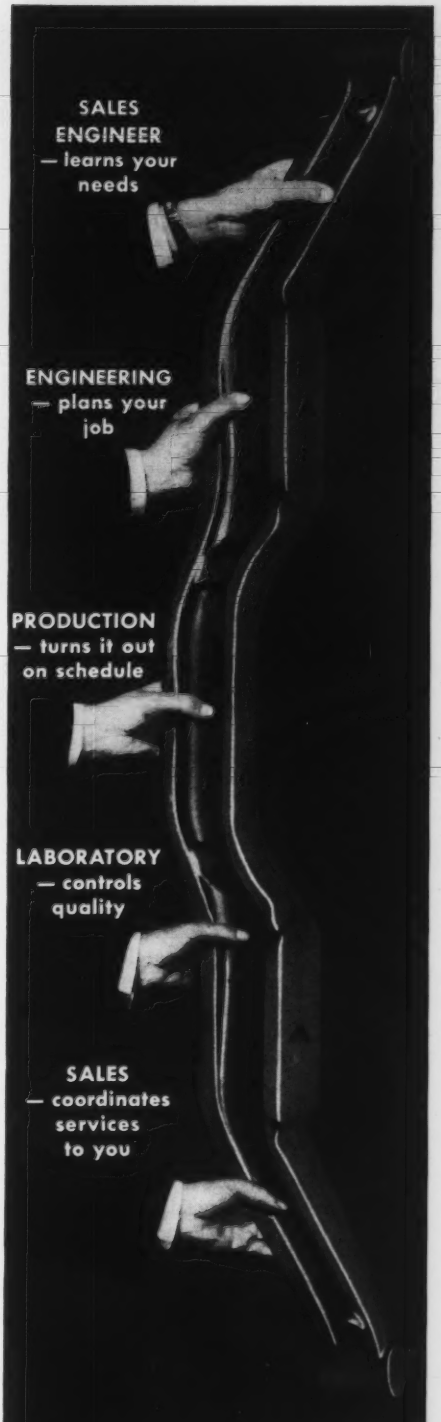
including operating temperature range of −65 to +200 F. **Inertia Switch Inc.**, 311 W. 43rd St., New York 36, N. Y. D

Circle 808 on Page 19

Indicating Dials

provide readings of potentiometer full turns

Model 10 and 20 Multidials are ten-turn indicating dials which provide immediate, error-free readings of



IT'S A TEAM AT T&W

that gives you the part you need

When you buy forgings or stampings from T&W, an entire team swings into action. These experts make sure you get what you need on time. This coordinated teamwork is a part of *T & W Technique* which gives you forgings and stampings which usually cost you less at your point of assembly.

SALES OFFICES:
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TRANSUE & WILLIAMS
ALLIANCE, OHIO, U. S. A.

Name _____ Title _____
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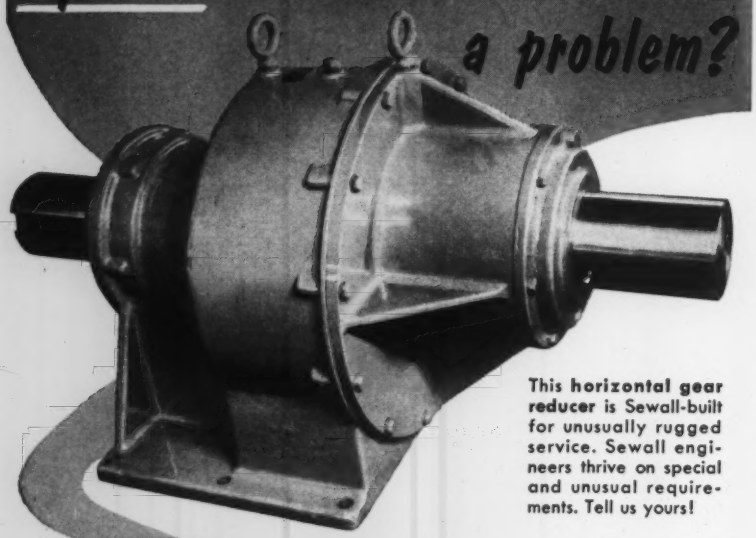
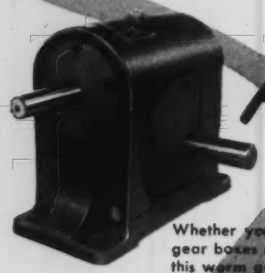
City _____ State _____

Special GEAR BOXES a problem?



This horizontal gear reducer is Sewall-built for unusually rugged service. Sewall engineers thrive on special and unusual requirements. Tell us yours!

Announcing!



Whether you need gear boxes such as this worm gear reducer in custom or mass produced quantities, it will pay you to talk to Sewall.

For the complete service . . . design . . . development . . . manufacturing . . . on special gear assemblies (sample illustrated) call Sewall.

A new Sewall Service . . . designing, development and manufacturing . . . to help solve your special gear box problems . . . effectively . . . economically. We're ready to work with you at any stage of your project's development.

From scratch . . . our gear box designers will go to work for you right now. Give us a rough outline of your idea. We're staffed and equipped to design and manufacture gear boxes whatever the size and description of your requirements.

To your specifications . . . let us submit our quotation on producing your order in strict accordance with your prints. Sewall gear boxes are made by men who are fussy about specifications. Your order must be delivered as scheduled . . . priced right. Let us hear from you!

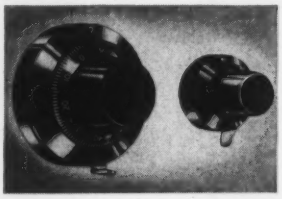
Sewall's complete gear service can help you . . . custom made gears . . . made-to-order sprockets . . . special gear racks—to order . . . standard gear racks in stock.

SEWALL GEARS

E. B. SEWALL MANUFACTURING COMPANY

705 Raymond Avenue, Dept. A, ST. PAUL 14, MINNESOTA, Midway 5-7721

potentiometer full turns. Only one number appears in turns-totaling window as each turn is completed. Proper turn number clicks into view and stays firm while precisely calibrated dial registers partial turns in increments of 1/100. No gearing mechanisms are used, assuring smooth turning and long, reliable operation. No disassembly or panel



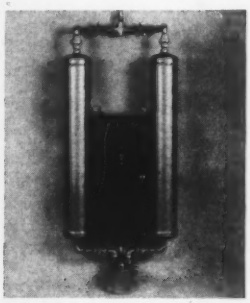
holes are required for mounting. Dial is available in 1-in. (Model 10) and 1 13/16-in. (Model 20) sizes to fit 0.25-in. diam shafts. Adapter bushing can be supplied for use with 0.125-in. diam shafts. **Spectrol Electronics Corp.**, 1704 S. Del Mar Ave., San Gabriel, Calif. M

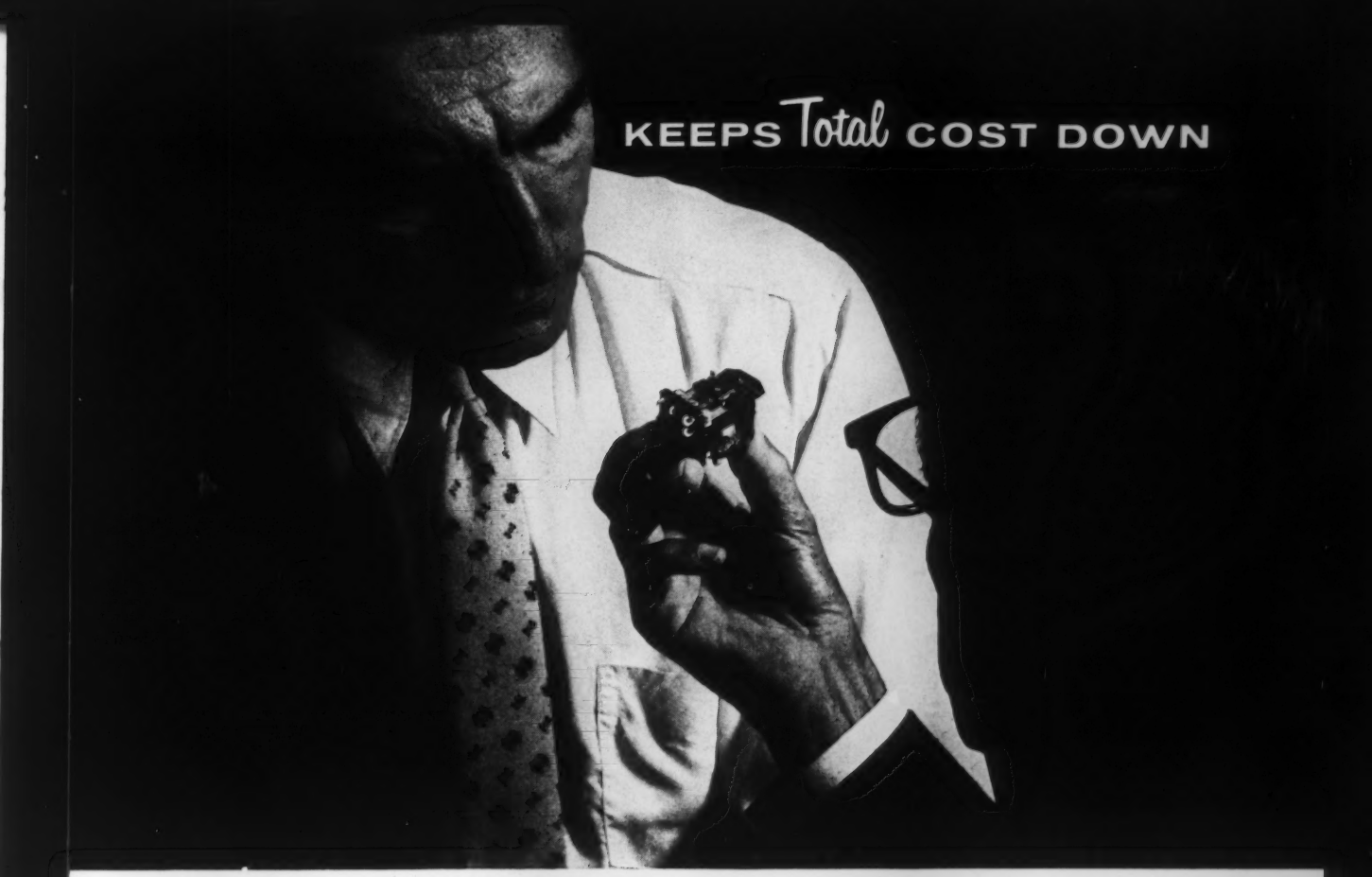
Circle 809 on Page 19

Compressed-Air Dryer

dries from 1 to 25 scfm of compressed air

Two sizes of small, compressed-air dryers are fully automatic, using a small amount of heat for reactivation. Only two moving parts, a timer and solenoid-type, four-way valve, are incorporated. Unit dries small quantities of compressed air, from 1 to 25 scfm, with inlet pressures to 125 psig and inlet temperatures to 120 F. Desiccant towers are throw-away type and are easily replaced. Built-in dust filters assure clean, dry air at dew points down to −60 F or below. Uses are dry air supply for controllers and instruments, precision air gages, coaxial cables and wave guides, and





IF INSTALLED-COST IS A DESIGN PROBLEM

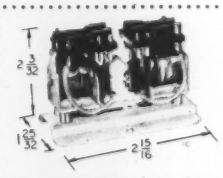
Look at the KA general purpose RELAY

What do your relays cost *installed?* Initial cost is never the whole story.

Our KA Relays are engineered for modern production methods. They're available with printed circuit, taper tab, quick-disconnect or hook solder terminals . . . are simple, economical to install. This fact, combined with low original cost, keeps your total cost down.

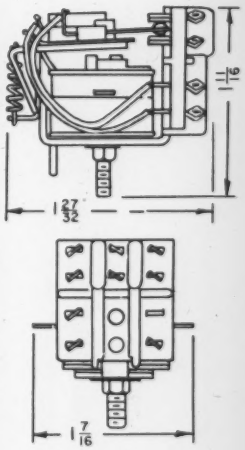
Another source for savings! All standard KA ac relays bear U/L and Canadian Standard Association seals of approval.

Write or call for more information or see the complete P&B catalog in Sweet's Product Design File.



KB LATCHING RELAY consists of two KA Relays, forming a mechanical latching relay, featuring a large number of contact arrangements.

KA ENGINEERING DATA



GENERAL:
- **Insulation Resistance:** 100 megohms min.
- **Breakdown Voltage:** 1500 V. rms between all elements.
- **Temperature Range:** −55° C. to +85° C. DC; −55° C. to +70° C. AC
- **Weight:** 2.0 ozs.
- **Pull-In:** DC 75% of nominal voltage. AC 78% of nominal voltage.
- **Terminals:** Taper tabs. Printed circuit. Quick-disconnect. Pierced solder lugs.
- **Enclosures:** Dust Cover (max. 55° C. ambient for AC relays) (max. 70° C. ambient for DC relays)

CONTACTS:
- **Arrangements:** 3 Form C (3PDT) max.
- **Material:** Movable—⅛" silver; stationary—5/32" wide silver overlay.
- **Load:** 5 amps @ 115 V. AC 60 cps res.

COILS:
- **Resistance:** 16,500 ohms max.
- **Power:** 1.2 watts (DC), 2 volt amps (AC)
- **Duty:** Continuous AC or DC (DC coils will stand 4.5 watts at 25° C.)

P&B STANDARD RELAYS ARE AVAILABLE AT YOUR LOCAL ELECTRONIC PARTS DISTRIBUTOR

Circle 593 on Page 19

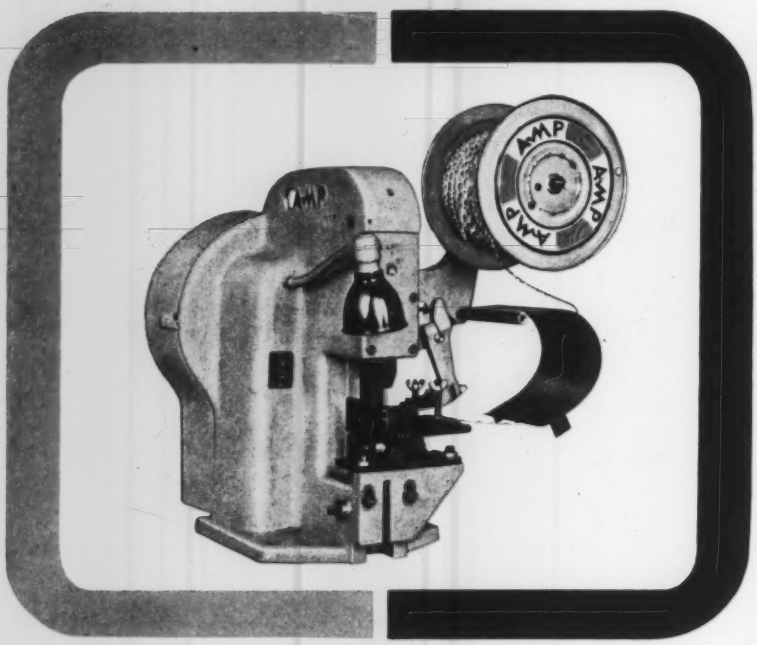
POTTER & BRUMFIELD

DIVISION OF AMERICAN MACHINE & FOUNDRY COMPANY, PRINCETON, INDIANA

IN CANADA: POTTER & BRUMFIELD CANADA LTD., GUELPH, ONTARIO

FASTER

THAN YOU CAN SAY "CIRCUIT TERMINATION BY AMP"



Speed—amazing speed—is fundamental with AMP's tool-and-terminal technique. In fact, an A-MP automachine can turn out 4,000 terminations per hour.

No extensive operator training is required. And, no large floor space—the bench-mounted Automachine takes up less space than an ordinary desk. It's built for safety, built for speed, built for reliable production day after day. And A-MP Automachine terminals are made in a size and shape to fit every requirement with such features as corrosion resistance, vibration resistance, and, if required, pre-insulation. Furthermore, actual costs of the AMP method are lower than any other method.

Why not learn more about this world famous compression-attachment method? Send for our descriptive literature.

AMP INCORPORATED

General Offices: Harrisburg, Pennsylvania

A-MP products and engineering assistance are available through subsidiary companies in: Canada • England • France • Holland • Japan

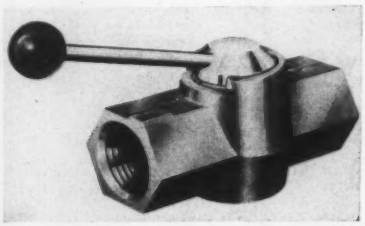
small unit processes or machine operations where dry air is essential. **Desomatic Products Inc.**, 1109 W. Broad St., Falls Church, Va. C

Circle 810 on Page 19

Plug Valve

for noncorrosive liquids or gases

Series 9200 brass plug valve is for pressures ranging from full vacuum to 150 psi. Valve can be used with virtually all noncorrosive liquids or gases and is available in ⅛, ¼, ½,



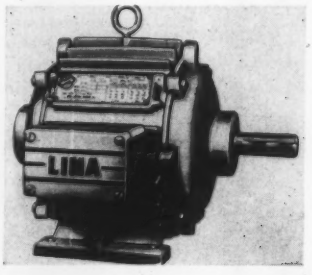
and ¾-in. female pipe sizes. Straight cylindrical plug uses O-rings for sealing. In open position, valve is full ported and allows straight-through flow passage. When closing valve, pressure depresses flow-sealing O-ring. Use of three O-rings virtually eliminates plug wear. **Circle Seal Products Co. Inc.**, 2181 E. Foothill Blvd., Pasadena, Calif. L

Circle 811 on Page 19

Fan-Duty Motors

in ½ through 15-hp sizes

Type EFD fan-duty motor is available in rerated NEMA frame sizes 182 through 326U (½ through 15 hp). Totally enclosed motors are furnished in speeds of 1800, 1200, or 900 rpm. Motors feature deep external cooling fins that assure adequate cooling with reduced transverse section to give lowest wind resistance. Duty rating is continuous, and temperature rise is rated



Circle 594 on Page 19

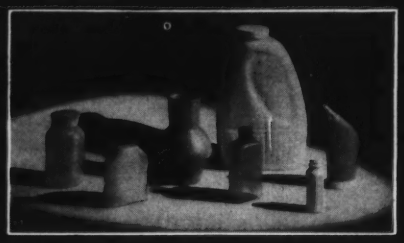
new, revolutionary, unique—won't freeze, won't stick—Here, for the first time, is a variable speed sheave that won't freeze, won't stick. It's Wood's new "MS" motion control sheave and it completely eliminates problems resulting from fretting corrosion. No more downtime, running through the speed range or dismantling. And, under normal operating conditions, the oil reservoir requires checking only twice a year. These startling advantages are made possible by two exclusive and revolutionary features . . . Wood's resilient rubber keys and continuous, rotational oil pumping action. Don't miss these and many other advantages.

send for bulletin 4101

Woods

T. B. WOOD'S SONS COMPANY
CHAMBERSBURG, PENNSYLVANIA
ATLANTA • CAMBRIDGE • CHICAGO • CLEVELAND • DALLAS

TODAY



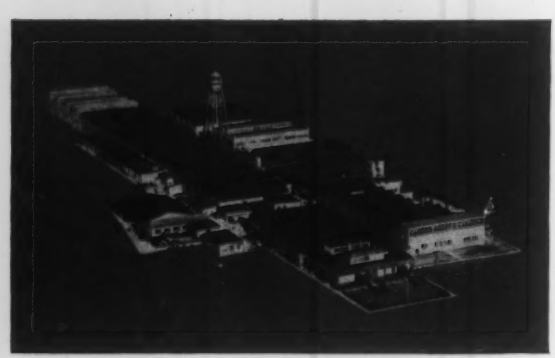
BLOW MOLDING COMES OF AGE

nosco's "can do" engineering is why

Nosco's latest expansion is headline news for the user of blow molded products. After today, practical engineering will support your projects. It has been four years since our injection molding customers asked us to devote our "Can Do" engineering and production skills to blow molding. Four years of technical analysis and planning to correct prevalent deficiencies.

what engineered blow molding means to you

- *Balanced Wall Thickness*
- *Statistical Quality Control*
- *Low Tooling-up Cost*
- *Broad Materials Selection*



For 23 years, Nosco "Can Do" has meant improved quality and craftsmanship in injection molding. Now these same high caliber engineering and production skills—plus Nosco's industry—leading finishing department—will benefit the user of blow molding services. There's a Nosco representative near you. He is competent to show you how Nosco's experience will benefit your products. Or contact us direct.

NOSCO plastics, inc. · erie 2, pa. *One of the world's great injection molders.*

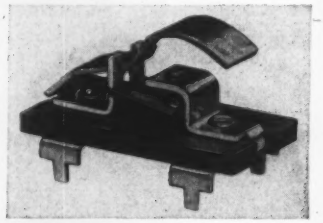
at 55 C. Other construction features include rigid, seasoned cast-iron frames with integral feet; die-cast rotors, dynamically balanced; double-width, prelubricated, sealed ball bearings which require no greasing or cleaning. Motors are available for two or three-phase operation in all standard frequencies and commercial voltages below 600 v. **Lima Electric Motor Co. Inc.**, Dept. 139, Lima, Ohio. G

Circle 812 on Page 19

Snap-Action Switch

for printed circuits

Special terminals for easy printed-circuit insertion are featured in S30-42B miniature snap-action switch. In addition to low cost, long life, and accurate repeatability, switch has positive overtravel stop



and over 50 actuator variations. Gold flash and other special contact material is available for low-voltage applications. Switch measures ¼ x ½ x 1 in. It is rated 10 amp, 125 v ac, 5 amp, 250 v ac, and ⅓ hp, 125/250 v ac. **Cherry Electrical Products Corp.**, 1650 Deerfield Rd., Highland Park, Ill. I

Circle 813 on Page 19

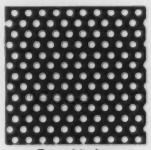
Molding Material

resin-rubber blend has high rigidity

Kralastic MM is a resin-rubber blend specifically designed for molding products where high rigidity and resistance to cold flow under loads are required. A medium-impact plastic, it is about twice as rigid as nylon, and resistance to creep is four times greater. Applications include business-machine housings, blades for home fans, data block assemblies for electronic computers, gears, pulleys, and squirrel-cage blowers. Plastic has low moisture pick-up, good impact strength,

LET H&K PERFORATED MATERIALS

put personality into your products

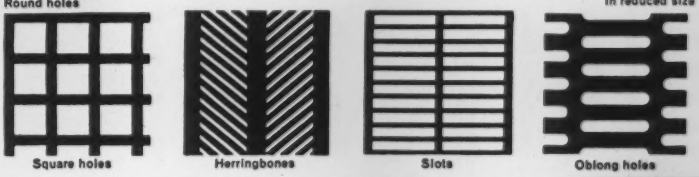


Round holes

Whenever—wherever—your products require perforated materials, you will find the pattern and open area "just right" for that custom-look in the vast selection of H & K existing dies.

Modern facilities and H & K experienced craftsmanship, enable the perforating of practically all metals, wood, compositions and plastic. Perforated materials can be furnished in sheets, coils, rolls or plates. Fabricating services include shearing, rolling, welding and forming.

Illustrations shown in reduced size

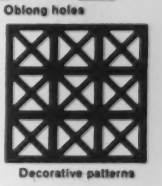


Square holes · Herringbones · Slots · Oblong holes

Functional or Decorative Uses

H & K fills every need for perforated materials. Appropriate perforated metals can be ordered with color anodized, brushed and lacquered, painted, chrome plated, baked-on, or other special finishes.

Many patterns in steel sheets (industrial or decorative) are in stock at our warehouses. Send for H & K Stock List Brochure.



Decorative patterns

Write for General Catalog No. 75, Today!

THE Harrington & King PERFORATING CO. INC.

Chicago Office and Warehouse • *New York Office and Warehouse*

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114 Liberty Street, Dept. MD, New York, New York

FIND NEAREST H&K AGENT in the "Yellow Pages"

Listed Under "Perforated Metals"

Circle 597 on Page 19

A HANDFUL OF POWER

DOWTY Pressure Balanced HYDRAULIC GEAR PUMPS

Pressures to 2500 PSI • Outputs from 1/2-60 GPM

Shown here is our Model GP2-85 which will deliver 18 GPM at pressures to 2000 PSI. Volumetric efficiency exceeds 95% throughout the operating range. Fully pressurized lubrication independent of discharge pressure. 14 other sizes available.

MAIL FOR COMPLETE DATA

Berry Hydraulics
2228 Oliver Building
Pittsburgh 22, Pa.

Name_____

Company_____

Address_____

Berry Hydraulics

A Division of Oliver Tyrone Corp.

Circle 598 on Page 19

WAPAK HARDENED WAYS LAST LIFETIME OF YOUR MACHINES

Engineered from solid tool steel, WAPAK Hardened Ways are uniformly hard through and through . . . No galling, scoring or other failure throughout lifetime of your machines . . . even under rugged service. Carburized or laid steel ways also available in some sizes.

MICRO-GROUND FINISH

Utmost care is given to accuracy of finish on all WAPAK Hardened Ways. Micro-Grinding is followed by individual inspection of each piece with Profilometer.

ENGINEERED TO SPECIFICATIONS

WAPAK Ways are manufactured to your blue print specifications and normal deliveries maintained. Your machines are more reliable with WAPAK Hardened Ways.

THE WAPAKONETA MACHINE CO.

Knives Engineered for the Job Since 1891

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Also manufacturers of SLITTER KNIVES • SHEAR BLADES • ROTARY SHEAR KNIVES • SCRAP CHOPPERS • HARDENED SPACERS • GIBS • ROCKER PLATES • WEARING PLATES • BALL RACES • WEAR STRIPS • MACHINE LINERS • MACHINE KNIVES for all industries.

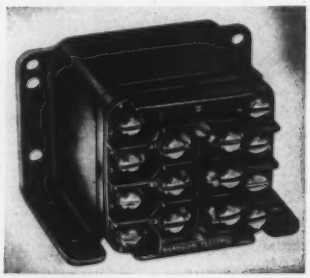
and high abrasion and corrosion resistance. It withstands heat, while maintaining usable strength, to 200 F. Material is available in a range of colors, and parts molded from it have good gloss. Parts can also be painted, printed, and cemented with solvents. **United States Rubber Co.**, 1230 Avenue of the Americas, New York 20, N. Y. C

Circle 814 on Page 19

Hermetically Sealed Relay

resists 15-g vibration to 100 cycles

Series 3005 hermetically sealed relay meets overload rupture, vibration, and minimum current requirements of MIL-R-6106-C. Relay operates with four-pole, double-throw contact-switch combinations at 10 amp. It has vibration resistance of 15 g to 1000 cycles and 10 g from 1000



to 2000 cycles. Relay is applicable for operation in temperatures from −65 to +120 C. Standard coil voltage is 24 to 28 v dc, and unit is also available with rectification network for ac operation to 400 cps. **Guardian Electric Mfg. Co.**, 1621 W. Walnut St., Chicago 12, Ill. J

Circle 815 on Page 19

Control Valves

have one-piece solenoid pilot housing

Improved Speed King plug-in, ¼-in., pilot-operated control valves feature aluminum bodies and subbases, and one-piece solenoid pilot housings. Built-in plugs and connectors complete electrical connections as body and pilot are bolted into place. All pneumatic or fluid connections also are made automatically as components are joined together. Valves are offered in single and double-solenoid types, for sub-

NEW Customer Service from MORSE—

Double-Pitch Sprockets and Chain Combination "Right off the Shelf!"

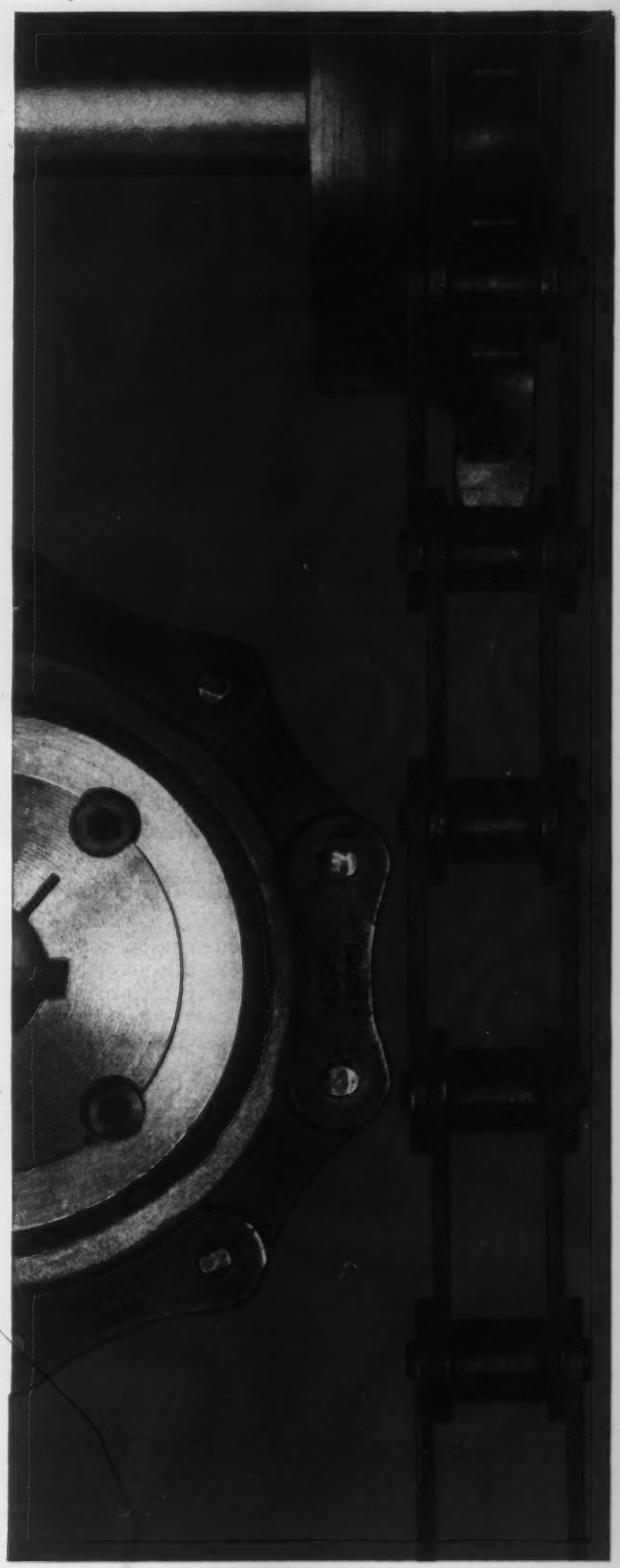
If your equipment design calls for low-speed transmission up to 500 rpm, here's the good news of on-the-spot delivery.

Morse precision, double-pitch stock sprockets, coupled with Morse double-pitch chain make a perfect combination . . . ready for immediate delivery . . . with no special machining time needed. These Morse components, right off the shelf, provide lighter, smoother, more compact power transmission. Their low cost, from big-volume stock production, is also an important factor.

Morse Taper-lock® double-pitch sprockets with odd number tooth design of 17, 19, 21, 23, 25, or 35 cut teeth give double service life, since each tooth engages the chain only every other revolution.

Morse double-pitch roller chain is precision made to A.S.A. standards. Packed in convenient 10-ft. lengths, Morse double-pitch chain comes in 1″ to 2″ pitch for power transmission and in 1″ to 2½″ pitch for conveyor service.

So, if your chain problem is packaging, farm machinery, conveyor, power transmission, or timing drives you'll find your answer waiting at Morse Chain Company, Dept. 6-119, Ithaca, N. Y. Export Sales: Borg-Warner International, Chicago 3, Illinois. In Canada: Morse Chain of Canada, Ltd., Simcoe, Ontario.



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MORSE B-W * A BORG-WARNER INDUSTRY

ONLY MORSE OFFERS ALL FOUR: Roller Chain, Silent Chain, Hy-Vo® Drives and "Timing"® Belts.

Circle 600 on Page 19

TI-designed, completely automatic transistor evaluator, FAST (Facility for Automatic Sorting and Testing), tests up to 12 parameters, classifies as many as 5 transistor types within each of 3 families, and is capable of punching test results onto 8-hole paper tape . . . at rates up to 1900 per hour.

MECHANIZATION ENGINEER

your future: a challenging opportunity with an industry leader

In a company which recognizes mechanization as one of its most vital areas, you can speed your professional growth with a challenging assignment. An example: The FAST machine above — one of the most sophisticated semiconductor test equipments in industry usage today!

Texas Instruments plans to increase its margin of leadership in design and manufacturing through the steady growth of its top-talent mechanization team.

Your personal growth as a part of this team will be accompanied by advanced personnel benefits including profit sharing (last year 15% of base salary), and premium living furnished by Dallas' climate, neighborhoods, schools and shopping facilities.

Interviews will be held in your area soon. If you have a high degree of mechanical aptitude and at least three years' associated work, please send a resume to

C. A. Besio, Dept. 204-MD

For immediate Eastern appointment, contact H. C. Laur Dept. 204-E-MD 1141 E. Jersey St. Elizabeth, N. J.

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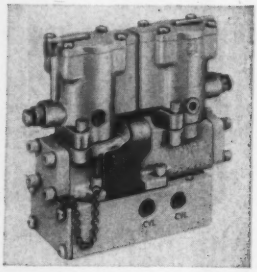


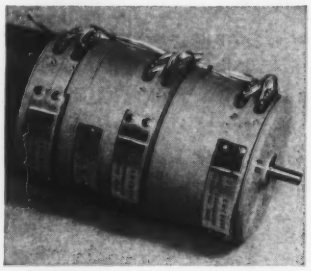
base or multiple manifold mounting. Designed for 30 to 200 psi service, valves are available with solenoid coils for ac or dc, any voltage. Cylinder ports and inlet are tapped ¼ in. NPT; exhaust is tapped ⅜ in. NPT. **Valvair Corp.**, 454 Morgan Ave., Akron 11, Ohio. F

Circle 816 on Page 19

Encoder Assembly

for use where minimum size and weight are needed

One million shaft positions can be resolved with Model CG-704 geared encoder assembly. Designed for use where minimum size and weight are important, assembly uses three shaft-position encoders and two gear boxes. It is 3 in. in diam, 5 in. long (exclusive of shaft), and



weighs less than 2 lb. Unit operates accurately at temperatures from 32 to 150 F and at 2000 cps to 8 g. **Datex Corp.**, 1307 S. Myrtle Ave., Monrovia, Calif. L

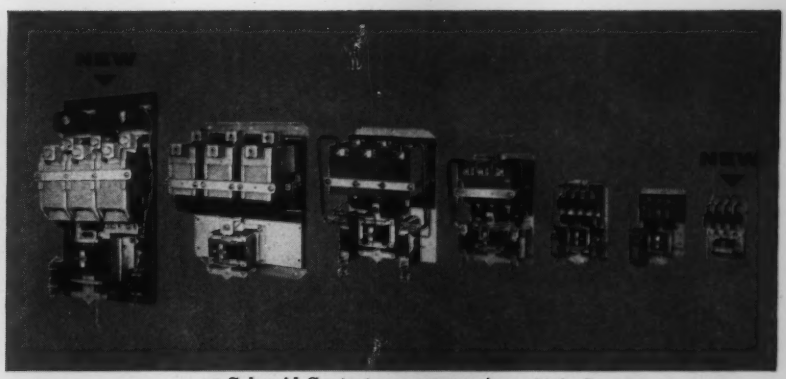
Circle 817 on Page 19

Adjustable-Voltage Drive

is extremely reliable, quiet-operating unit

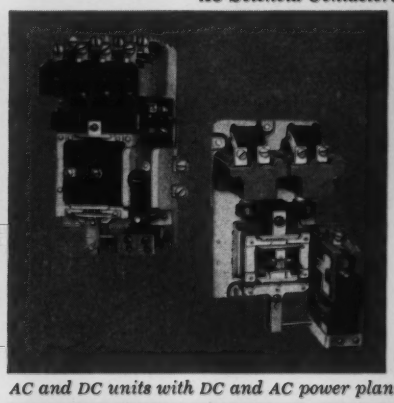
Adjustable-voltage drive, using static-power magnetic amplifiers, provides extremely high reliability and quiet operation. Magnetic amplifiers and semiconductors are used for control and rectification of input

HERE'S A CONTROL COMPONENT LINE YOU CAN STAKE YOUR REPUTATION ON

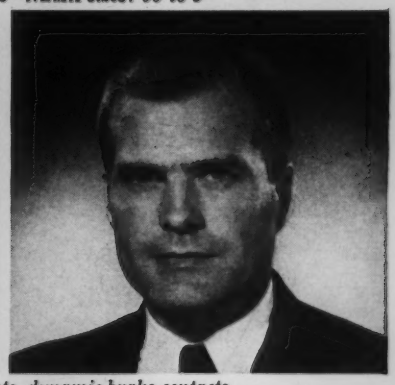


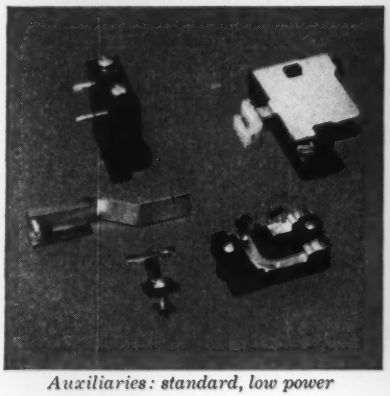
AC Solenoid Contactors • NEMA sizes: 00 to 5

DC Solenoid Contactors to size 4

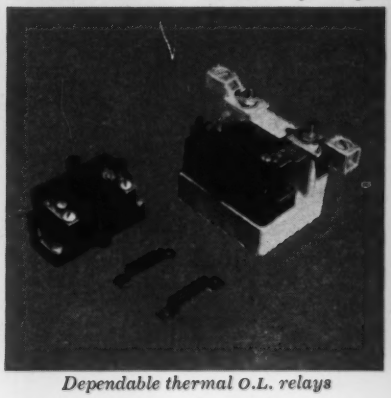


AC and DC units with DC and AC power plants, dynamic brake contacts

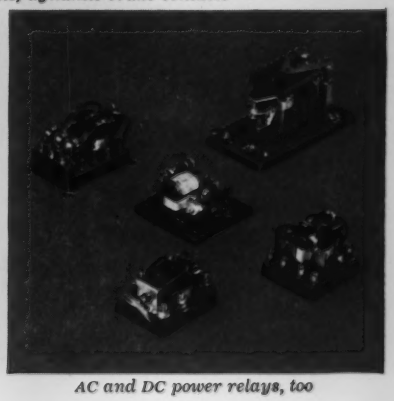




Auxiliaries: standard, low power



Dependable thermal O.L. relays



AC and DC power relays, too

It's completely versatile and designed for both standard and specialized controls

From the little Size 00's to the powerful Size 5 contactors you'll find maximum reliability built right in . . . whether your application is in motor control, resistive heating or lamp switching.

Meticulous attention to design features guarantees you top-notch performance . . . especially where hi-reliability is a "must." All AC and DC contactors for example, come equipped with simple, fast-acting, trouble-free solenoids. There are no complicated linkages or potentially troublesome pins or bearings . . . no adjustments needed either.

The main *and* auxiliary contacts are of the double break type designed for maximum reliability even where high in-rush currents are met. Contacts are accessible for inspection, too!

Other key contactor design features include: identical mounting centers for AC *and* DC; all units designed for front-of-board wiring *and* mounting; magnetic blowouts furnished above 25 amp. size on DC; fully accessible terminals make installation easy.

On your next control job, standard or special, specify W/L Control Components. Send for detailed Control Catalog: Ward Leonard Electric Co., 58 South St., Mount Vernon, N. Y. (In Canada: Ward Leonard of Canada, Ltd., Toronto.) 9.5

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LIVE BETTER...*Electrically*

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RESISTORS | RHEOSTATS | RELAYS | CONTROLS | DIMMERS

Circle 602 on Page 19

New High-Strength Material Extends Superior Line of Stainless Steel Tubing Analyses

PH 15-7 Mo, a new precipitation-hardening stainless steel analysis, possesses excellent mechanical properties at room temperature, outstanding ones at elevated temperatures. In addition, it is readily fabricated in the annealed condition, exhibits good corrosion resistance characteristics, can be hardened by heat treatment with minimum distortion.

Tubing of this new analysis is recommended for aircraft structural parts, studs and bushings, Bourdon springs and torque tubes in instrumentation, tubular springs, and hydraulic lines where severe bending and forming are required. It is available in WELDRAWN® form in size range from .012 through 1.125 in. OD.

In addition to PH 15-7 Mo, Superior offers the widest variety of analyses in the small-diameter tubing industry—over 120. This range permits you to specify the right one for your particular application. For complete information about PH 15-7 Mo and other analyses available for your needs, write Superior Tube Company, 2010 Germantown Ave., Norristown, Pa.

*Reg. U.S. Pat. Off., Armco Steel Corp.

Superior Tube

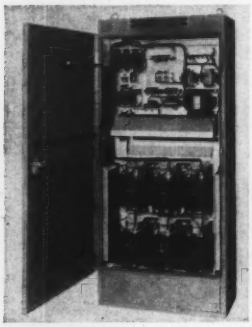
The big name in small tubing

NORRISTOWN, PA.

All analyses .010 in. to ⅝ in. OD—certain analyses in light walls up to 2½ in. OD

West Coast: Pacific Tube Company, Los Angeles, California • FIRST STEEL TUBE MILL IN THE WEST

Circle 603 on Page 19



power. Drive is particularly well suited for applications where warm-up time or vibration cannot be permitted. Sizes range from ½ to 200 hp, and feature 8:1 speed range with 5 per cent regulation. Standard modifications include dynamic braking, reversing, jogging, and dynamic slowdown. **Square D Co.**, 4041 N. Richards St., Milwaukee 12, Wis. K

Circle 818 on Page 19

Stainless-Steel Strip

has improved forming characteristics

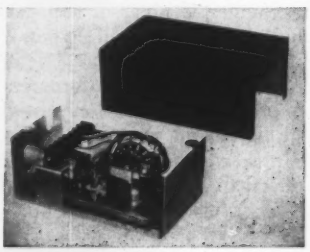
New grade of straight-chromium stainless-steel strip is designated Uniloy 435. It provides better workability than Type 430 when used in stretch bending and deep drawing. Surface characteristics and corrosion resistance are equal to Type 430. **Universal-Cyclops Steel Corp.**, Bridgeville, Pa. G

Circle 819 on Page 19

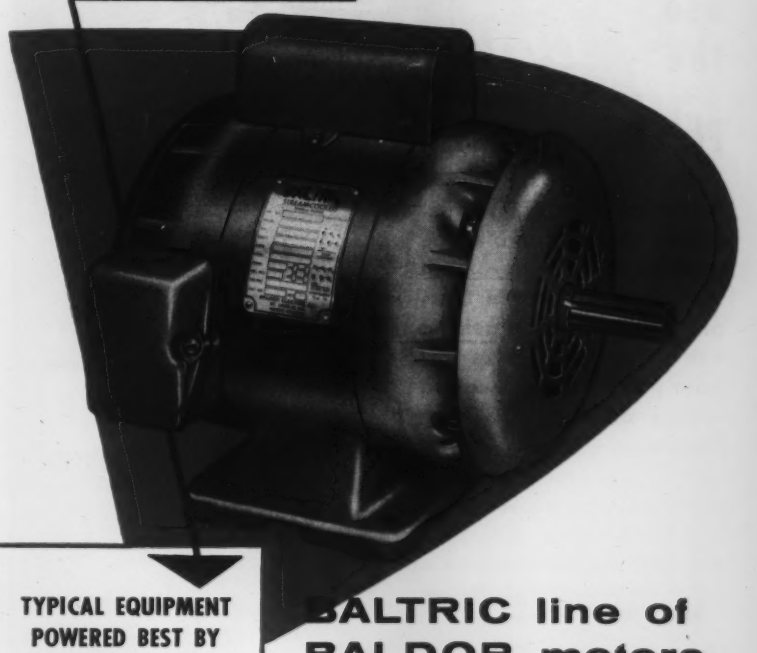
Sequence Controller

switches 2 to 12 circuits in predetermined sequence

Sequence controller is an electrically operated device, designated SC 500, which switches from 2 to 12 circuits in a predetermined sequence. Unit has excellent flexibility of operation, making possible an



Specially designed with the APPLICATION in mind!



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Blowers
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No guesswork here! Now you can stop fitting the machine to the motor.

Famous Baldor Streamcooled Motors featuring TEFC construction, are engineered and designed to fit *specific* applications—your guarantee of getting the *one right* motor that will deliver the power and performance to make your equipment operate at top efficiency.

There's a highly trained and experienced Baldor representative near you who will be happy to show you how this "tailored-to-the-job" type of engineering can help cut costs and improve the performance of your equipment. Contact him direct or write to . . .

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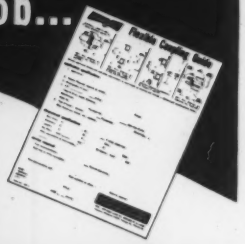
Circle 604 on Page 19

To Get The Flexible Coupling Best Suited For Your Job...

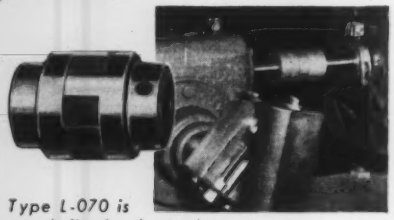
use the **Lovejoy**

Flexible Coupling Guide

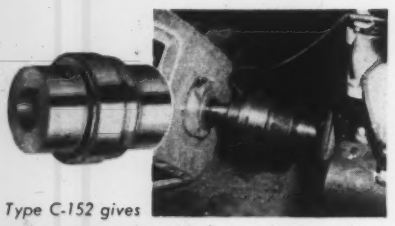


Save time, money and mistakes, insure trouble-free performance . . . by using the Lovejoy Flexible Coupling Guide. You'll get the exact type and size for your particular application —*plus all these Lovejoy features:*

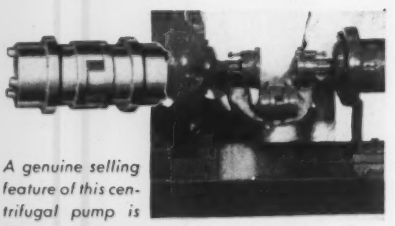
- No lubrication required.
- Simple, rugged construction—few parts, no intricate mechanisms.
- No wear on metal parts—the load is transmitted through cushions only.
- Double-life cushions—one half the cushions act as idlers, except on reversing loads. Thus, a quick interchange provides a new set of cushions.
- Cushions engineered to load and service conditions.
- A maintenance-free coupling that is completely machined for ease and speed of alignment.



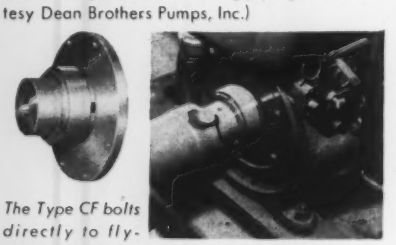
Type L-070 is exactly fitted to the requirements of this gear pump.



Type C-152 gives maintenance and trouble-free performance in a portable power unit.



A genuine selling feature of this centrifugal pump is the spacer type RRL which permits quick, easy disassembly without disturbing piping. (Courtesy Dean Brothers Pumps, Inc.)



The Type CF bolts directly to flywheel, reducing component requirements, cutting assembly time and providing a more compact unit.

● **Act now! Send for your Flexible Coupling Guide today.**

REQUEST CATALOG

LOVEJOY FLEXIBLE COUPLING CO.

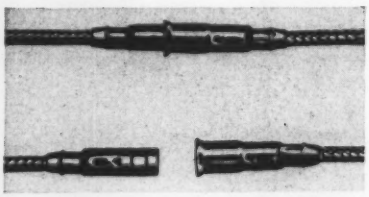
4818 WEST LAKE STREET • CHICAGO 44, ILLINOIS

almost limitless number of sequences and sequence combinations. Unit will repeat same predetermined sequence as long as actuating pulses are fed into it from a limit switch, foot switch, photoelectric-control relay, or any conventional equipment. Switch contacts are primarily pilot duty, 3 amp at 115 v ac. **Warco Industries Inc.**, 6625 Delmar Blvd., St. Louis 3, Mo. I

Circle 820 on Page 19

Coaxial Cable Disconnect

fits all cables to ¼ in. OD



Coaxicon coaxial and shielded cable disconnect has interchangeable contacts which permit a variation of inner conductor diameters in each cable size, either solid or stranded. Unit now fits all cables to ¼ in. OD. Application technique requires one crimp for complete assembly. Disconnect is designed for RG coaxial cable, standard coaxial cable, and other shielded - cable types. **AMP Inc.**, Eisenhower Blvd., Harrisburg, Pa. E

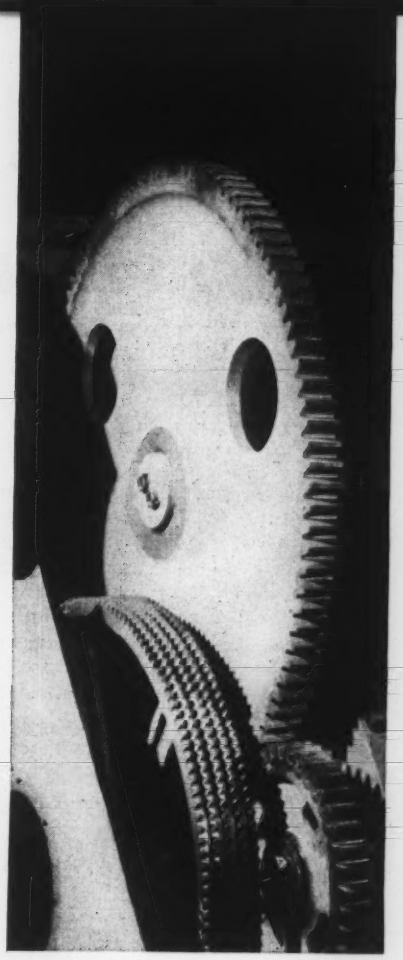
Circle 821 on Page 19

Pressure-Sensitive Tape

is fuel and chemical resistant

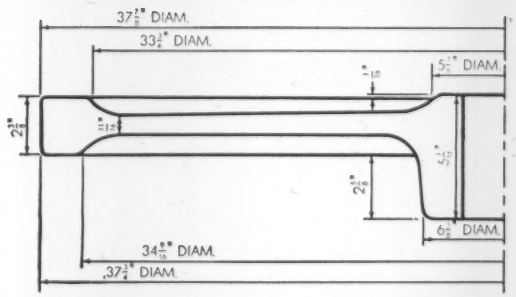
High - temperature, pressure - sensitive tape, known as Temp-R-Tape FR, is composed of a 3-mil Teflon backing and high-temperature fluoropolymer adhesive to total thickness of 6 mils. Resistant to many fuels and chemicals, it has useful temperature range of −50 to over +400 F. Dielectric strength is 1600 v per mil. Suggested areas of application include engines of all types, hydraulic equipment, and chemical pipelines. Tape also affords excellent protective insulation on electrical parts and wiring in areas of splicing and harness wrapping. **Connecticut Hard Rubber Co.**, 407 East St., New Haven 9, Conn. B

Circle 822 on Page 19



GEAR *installed in hoist mechanism of Koehring Company power shovel.*

EXCELLENT *response to induction hardening? Take a look!*



This gear now costs $35.24 less,

THANKS TO BETHLEHEM CIRCULAR FORGINGS

"We are also very pleased with product machining properties, freedom from defects in the tooth area, and excellent response of the forging to heat treatment."

KOEHRING COMPANY, MILWAUKEE, WISCONSIN
manufacturers of construction equipment

Koehring Co. previously machined this gear from a cast gear blank. Today they machine it from an impression-die steel forging made on Bethlehem's unique Slick Mill. They save $29.24 in first cost, plus $6.00 in machining costs! (Turning, boring, facing, and hobbing teeth.)

Here's how we do it

The answer, of course, lies in Bethlehem's Slick Mill—the only one of its kind in the country. Quick die set-up (only 15 minutes)—quick operation (just one minute to forge and roll a circular product)—low die charges (⅓ to ½ less than conventional impression dies)—and less steel needed (utilizing the principle of forging design, the Slick Mill can produce lighter-weight sections without sacrificing strength) . . . all these add up to important savings. At the same time, the process insures *soundness, excellent grain flow,* and *machinability.*

Bethlehem's Slick Mill saves the Koehring Company $35.24 *per gear.* How much can it save you?

Bethlehem Circular Forgings are available in carbon, alloy, or stainless steels, as well as certain heat-resistant grades. 10 to 48-in. OD. 100 to 2,000 lb. As-rolled, or rough-machined to specifications. Call or write the Bethlehem sales office nearest you for full details.

BETHLEHEM STEEL COMPANY, BETHLEHEM, PA.
Export Distributor: Bethlehem Steel Export Corporation

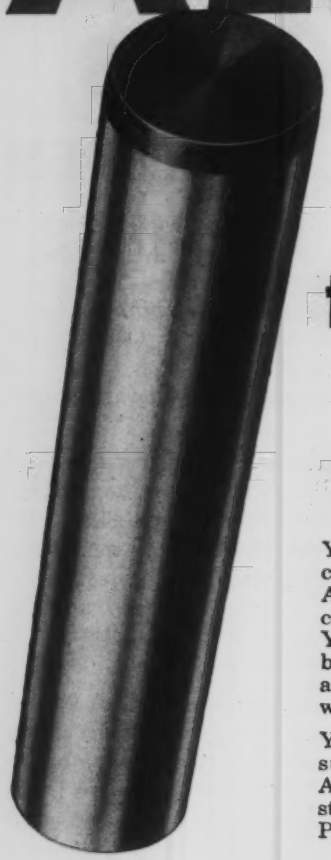
BETHLEHEM STEEL

NOTICE *the thin disc shape on this 395-lb gear blank. A cinch on the Slick Mill!*

BETHLEHEM STEEL

Circle 606 on Page 19

ALLEN

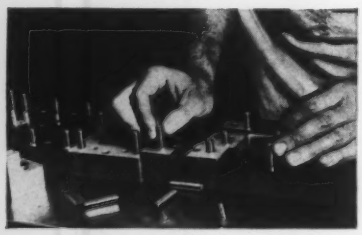


ALLEN is the dowel pin that gives you PLUSES!

Your ALLEN Industrial Distributor can show you a good many ways to use ALLEN Dowel Pins, in addition to conventional uses in tool and die work. You can use them as economical roller bearings, axles, precision plugs, hinge and wrist pins—and in many other ways.

You can cut the cost of your product substantially, too—because your ALLEN Distributor can supply these strong, accurate, mirror-finished Dowel Pins in standard sizes right from stock.

Made of special Allenoy steel; surface hardened to 62-64 Rockwell C; precision ground to .0001" with micro-inch finish of 6 RMS max. Check your Allen Handbook or Catalog for detailed specs and standard sizes, or write direct for samples and technical information.



Genuine ALLEN products are available only through your ALLEN Distributor—he's always ready, willing and able to give you prompt, practical service.

ALLEN MANUFACTURING COMPANY
Hartford 1, Connecticut

ALLEN HEAD
HEX-SOCKET SCREWS

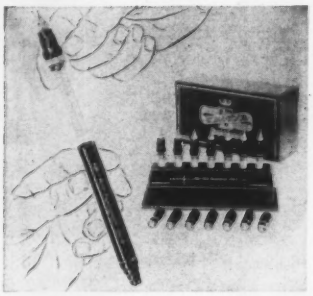
ENGINEERING DEPARTMENT

EQUIPMENT

Fountain Pen

for drawing, ruling, and lettering

Rapidograph technical fountain pen, Model 3065, makes available for drawing, ruling, and lettering a single holder with seven interchangeable point sections that provide seven different line widths—00, 0, 1, 2, 2½, 3, and 4. Each point section has its own refillable, translucent-plastic ink cartridge. Set



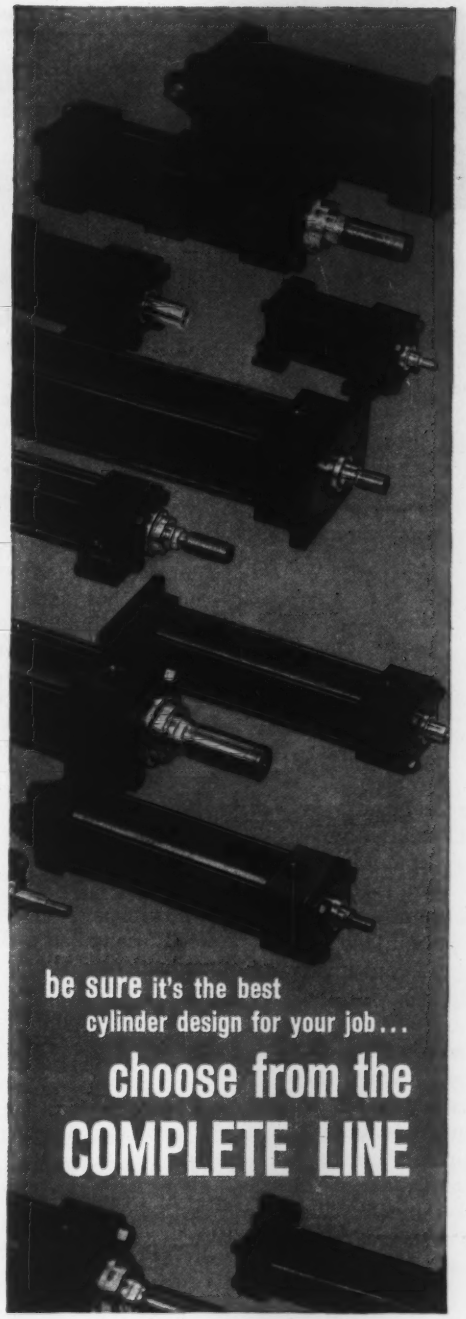
is furnished with squeeze-bottle dispenser for ink in a box that serves as a permanent container for holder and point sections. Each point section is numbered and color-coded for instant identification of line width. Interchange of points is accomplished easily, and in complete cleanliness. Point sections and all other parts are acid-resistant, permitting use of all types of drawing, regular, and acetate inks. **Koh-I-Noor Pencil Co.**, Bloomsbury, N. J. D

Circle 823 on Page 19

Piezoelectric Accelerometer

doughnut-shaped unit is screwed or cemented down

Glennite self-generating accelerometer, Model A-3100T, is a doughnut-shaped, lightweight unit designed for laboratory or in-flight shock and vibration measurements. It features optional screw or cement-down mounting. Bonded to a vibrating structure with cement or



Available for immediate shipment from stock for over 90% of all applications

Only Hydro-Line offers you the "Complete Line" of three series of industry standard, modern design cylinders enabling you to choose the type best suited to your job requirements. You needn't pay for "too much" cylinder for the job, nor do you have to "stretch" and risk tying up production by not buying "enough" cylinder.

Because all three series are standard, you keep initial cylinder costs low.

Because all three are standard series, you get fast delivery from factory stocks, permitting reduced inventories.

Here are the three standard Hydro-Line series that combine the newest ideas in cylinder design with proved performance in all classes of industrial service:

series R2 — 200 psi air, 500-2500 psi hydraulic, 1½" to 14" bores; meet J I C standards.

series N — 2000 psi and higher hydraulic service; 1½" to 12" bores; meet J I C standards.

series S2 — 200 psi air, 1000 psi hydraulic, ½" to 8" bores; meet J I C and automotive industry automation standards.

For more complete data on sizes carried in factory stocks — covering 90% of applications and including thousands of bore, stroke and cushion combinations, contact your nearby Hydro-Line representative or fill in coupon below and send direct to factory:

Please send me additional data on the classes of Hydro-Line cylinders checked below, including complete information on deliveries from factory stocks:

( ) Series R2 (heavy-duty air, medium-duty hydraulic, industry standard)
( ) Series N (heavy-duty hydraulic, industry standard)
( ) Series S2 (automotive industry automation standards)

Name and Title_____
Company_____
City_____ State_____

HYDRO-LINE MANUFACTURING COMPANY
5602 PIKE ROAD ROCKFORD, ILLINOIS

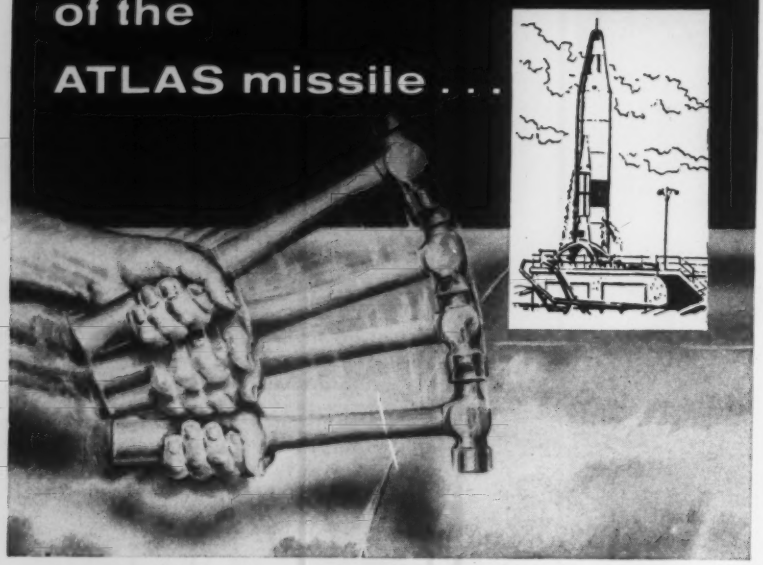
HL HYDRO-LINE CYLINDERS

5602 PIKE ROAD • ROCKFORD, ILLINOIS

manufacturers of: high- and low-pressure hydraulic cylinders • heavy-duty air cylinders • adjustable-stroke cylinders • dispensing cylinders • intensifiers • single-acting cylinders • booster cylinders

Circle 608 on Page 19

How an ordinary hammer proved the case of the ATLAS missile . . .



The body of the missile, essentially one big fuel tank, is similar in principle to an inflated football. Convair-Astronautics broke new ground in missile design by developing a super-strong structure with a comparatively thin stainless steel skin to keep weight to a minimum. This stainless steel skin is so thin that the interior has to be pressurized to preserve the shape of the body as propellants are consumed in flight, or when the missile is being transported on the ground.

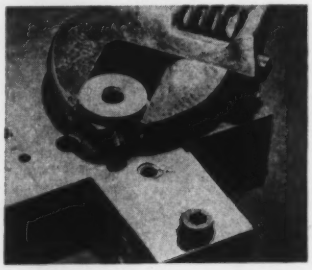
Some critics, however, thought the body was too fragile—"You could dent it with a hammer." So, recently, when the Scientific Advisory Board, engaged in a re-evaluation of all missile programs, arrived at Convair-Astronautics to take a reading on the ATLAS, they found that Convair had thoughtfully placed a number of hammers within easy reach of a finished missile. "Go ahead, bash it," invited Convair. The SAB members swung lustily. *Not a dent was registered*, for, although the walls are thin, the stainless has a minimum tensile strength of 200,000 psi.

This stainless steel skin material, supplied by Washington Steel, required extremely close control of mechanical properties and gauge tolerance which are regularly produced through Washington Steel's long experience with precision rolling equipment.

Stainless Steel—the Space Age Metal

Washington Steel Corporation

11-E Woodland Avenue
Washington, Pa.



double-faced, pressure-sentitive tape, accelerometer can be removed with a wrench without damage. Piezoelectric unit has isolated bender construction which eliminates torque sensitivity. Acceleration range is ±0.2 to ±1000 g peak, and resonant frequency is 14 kc. Weighing less than 10 grams, and occupying volume of less than 1.4 cu in., instrument has sensitivity of 4.5 mv per g minimum, temperature range of −65 to +250 F, and linearity of better than ±2 per cent of reading. **Gulton Industries Inc.**, 212 Durham Ave., Metuchen, N. J. D

Circle 824 on Page 19

Triangular Scales

two units are for engineers or architects

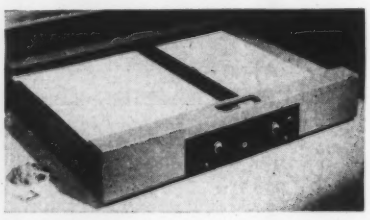
No. 110 and 111 seasoned-hardwood triangular scales have black graduations clearly imprinted against smooth, cream-colored, lacquer-finished surface. Scales have full-size profile and regular design. Scale No. 111, 12-in. model for engineers, is graduated in 10, 20, 30, 40, 50, and 60 parts to the inch. **Alvin & Co. Inc.**, 611 Palisado Ave., Windsor, Conn. B

Circle 825 on Page 19

X-Y Plotter

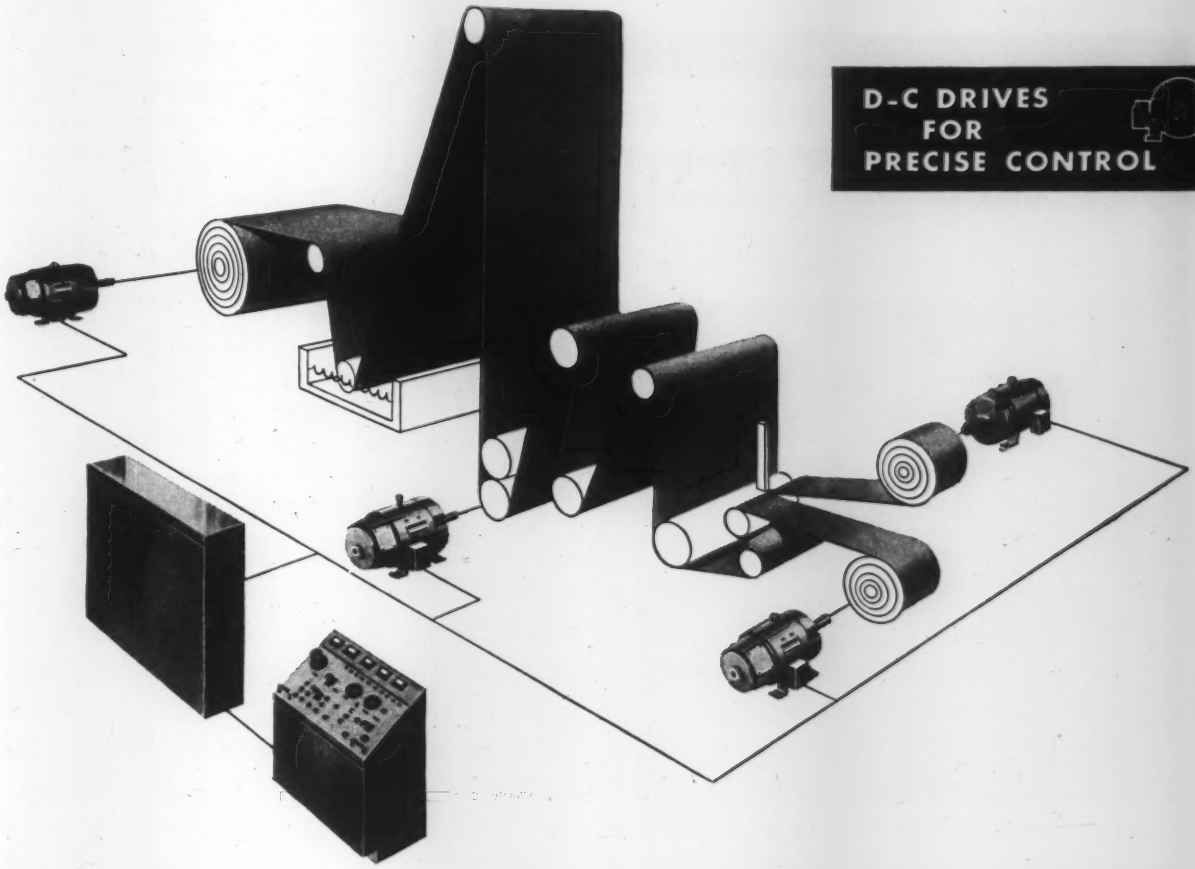
detects mechanical movements to 20 mu in.

HR-94 X-Y plotter, operating from differential transformers, plots small mechanical movements or any re-



Circle 609 on Page 19

D-C DRIVES FOR PRECISE CONTROL



Problem: How to control sheet or web tensions for faster machine operation, better quality

Tension inaccuracies during high speed production can result in torn sheet, costly production snarls, poor product quality. To control sheet or web tensions accurately, speeds of machines must be closely synchronized. Equipment must be brought up to top speed gradually—smoothly—without loss of tension. Often a dozen motors must respond as one—instantly. **Direct-current drives can best meet this need.**

In continuous processing—wherever accurate control is needed—direct-current adjustable-speed drives perform with instantaneous tension adjustment—smoothly, automatically. The result: faster machine operation, better quality, lower production cost.

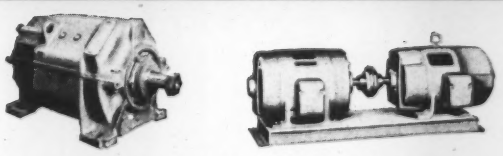
This is only one example of d-c's modern capabilities. Throughout industry there is a growing trend to more direct-current powered equipment. The reasons for this trend are explained in a new General Electric booklet called "WHY D-C?" For your free copy, write *Department 829-1, General Electric Co., Schenectady 5, New York.*

Progress Is Our Most Important Product

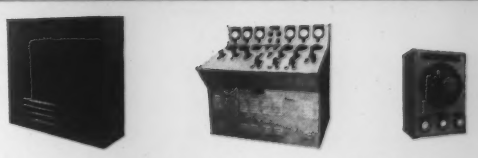
GENERAL ELECTRIC

Circle 610 on Page 19

SELECT FROM G.E.'S COMPLETE LINE OF D-C DRIVES

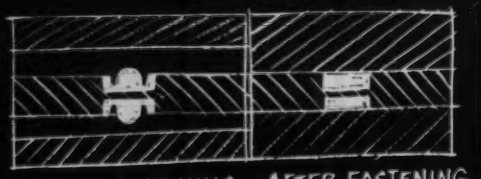


MOTORS AND GENERATORS



POWER UNITS AND CONTROLS

LEAKS *CAN* BE STOPPED!

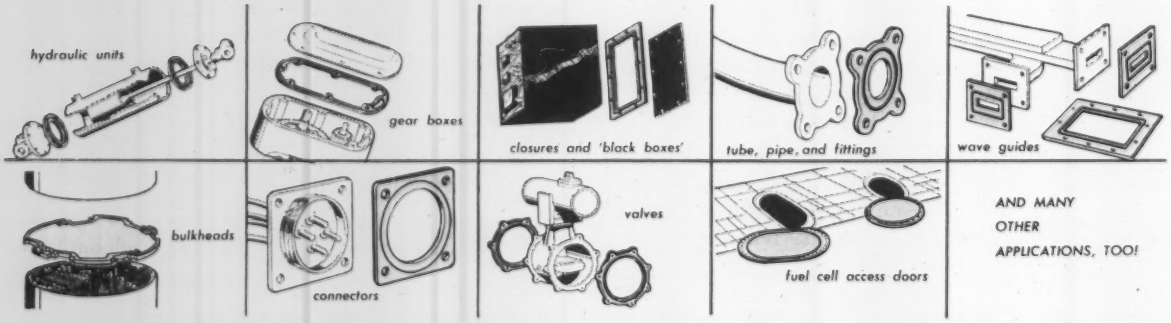


Controlled Confinement

Safe, sure sealing is vital in today's high performance machines, aircraft, missiles, ground support equipment and processing equipment and *there* is a better way to seal them . . . GASK-O-SEALS.

The Gask-O-Seals shown here are static seals that can actually provide sealing that will exceed hermetic top specifications. Yet, they are mechanical, can be removed, and reused. *Controlled confinement* of the rubber makes them superior to other seals.

The "typical" applications shown are just a few of the ways Gask-O-Seals are being used. Practical, *truly* economical, no-leakage sealing. If you want to *seal* for *sure*, find out about Gask-O-Seals. Just drop us a line or use the reader service card.



Parker SEAL COMPANY

CULVER CITY, CALIFORNIA and CLEVELAND, OHIO

A DIVISION OF PARKER-HANNIFIN CORPORATION

lated variables which can be converted to mechanical movements. Applications include plotting contours of miniature bearing races, mechanical inspection, plotting surface and gear-tooth irregularities, stress, strain, pressure, and spring and bellows deflections. Multiplication factor is accurately adjustable to 1000:1, and movements of 20 mu in. are readily detectable. Standard 24 x 36-in. D-size paper or 24-in. roll-stock graph paper can be used. Half-size sheets can also be used. Pen speed with standard servo is 2 ips. **Houston Instrument Corp.**, 1717 Clay Ave., Houston 3, Tex. P

Circle 826 on Page 19

Strain-Gage Recorder

gives stress data in psi figures

New system provides a simple and reliable method for recording in digital form the output of strain gages. It gives stress data in immediately usable psi figures. Rate of data recording is adjustable from 0.7 to 5 seconds per point. System provides for selection of up to 40 strain gages and is expansible in modules of 10 points up to a capacity of 100 points or more. It is packaged in a standard double instrumentation enclosure. **Datex Corp.**, 1307 S. Myrtle Ave., Monrovia, Calif. L

Circle 827 on Page 19

Large Circuit Board

for assembly of experimental circuits

Model 24 large circuit board contains a total of 352 separate contact cells to facilitate rapid assembly of experimental circuits using standard components and subsystems.

EMCOR®* CABINETS ENCLOSE "NERVE CENTERS" FOR AUTOMATIC PRODUCTION

EMCOR Cabinets house equipment for testing of microwave components at the TAPCO GROUP, Division of Thompson Ramo Wooldridge Inc., Cleveland, Ohio.

EMCOR Cabinets house "SMART" — The Sequential Mechanism for Automatic Recording and Testing designed and built by Texas Instruments Incorporated, Dallas, Texas. The unit evaluates transistors automatically and economically with consistent accuracy.

Standard EMCOR Cabinets prove their versatility and flexibility daily in industrial applications. Electronic computers, data loggers, readout gear, testing and research equipment are housed in EMCOR units in hundreds of key installations. Advanced EMCOR Engineering "know-how" in metal cabinetry is keeping pace with automatic production line operations. Costly custom housing design time is eliminated. The flexible, versatile and structural capabilities of over 600 basic frames in the EMCOR MODULAR ENCLOSURE SYSTEM solve the daily packaging problems of industrial design engineers. Let EMCOR Engineering "know-how" work for you. Write for full information today.

Your copy of catalog 106 condensed version available upon request

QUALITY® EMCOR PRODUCTS

Originators of the Modular Enclosure System

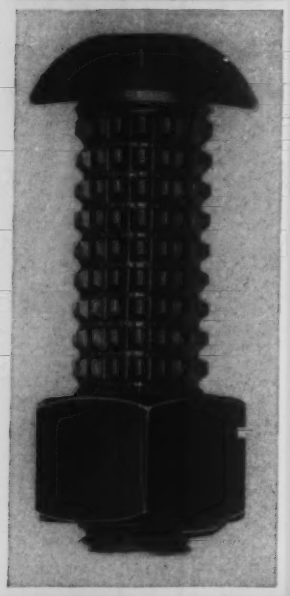
ELGIN METALFORMERS CORP.

630 CONGDON, DEPT. 1226 • ELGIN, ILLINOIS

*Registered Trademark of Elgin Metalformers Corporation

Circle 612 on Page 19

NEW!



ANCO

HIGH TENSILE

Structural Rib Bolts

For Structural Joints
Requiring The Extra Strength
Of High Tensile Steel

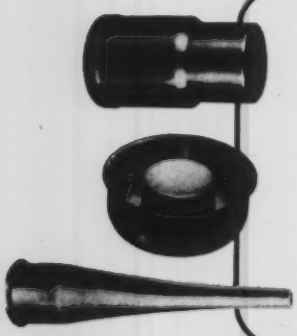
- Interrupted ribs fill hole to create joint in initial bearing . . . body-bound feature eliminates possibility of joint slippage
- Flat head and tapered ribs permit easy driving . . . ribs do not peel off or pack under head
- Designed with proper rib length . . . full thickness of plates in full bearing . . . no steel rides on threads
- Use with ANCO Lock Nuts for fast one-man assembly
- Can be furnished black or hot dip galvanized
- Technical data, price quotations and copy of university test reports upon request

AUTOMATIC NUT COMPANY
INCORPORATED
LEBANON, PENNSYLVANIA

Circle 613 on Page 19

Schrader Metal Spinnings & Hydroformings

• CUT TOOL AND DIE COSTS
• HOLD CLOSE TOLERANCES



PUMP COVER
⅛" stainless machined to ±.005.

STAINLESS STEEL SHROUD
Radius and dia. held to ±.001.

COPPER RESISTOR HOUSING
Wt. is ±¼ oz. on finished part.

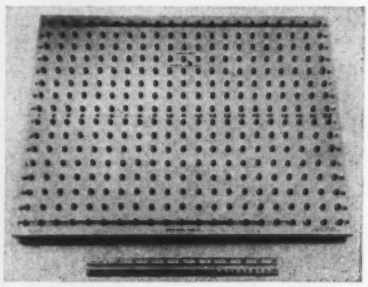
Schrader engineers have had extensive experience in producing odd shapes, short runs, and experimental parts with a minimum of set-up and tooling costs.

Write for Brochure
Dept. MD-7

Since 1897

J. Schrader Company
4603 FENWICK AVENUE, CLEVELAND 1, OHIO

Circle 614 on Page 19



Wires and component leads are electrically connected by inserting ends into individual cells, and two bus bars are also provided to simplify wiring layout. Flat board surface organizes circuit elements for ready analysis and study. Electrical values can be adjusted easily by interchanging resistors, capacitors, coils, and other components. Solderless connections are used throughout, minimizing component damage. **Plastic Associates**, 185 Mountain Rd., Laguna Beach, Calif. L

Circle 828 on Page 19

Motion-Picture Film

is high-speed, color film for technical use

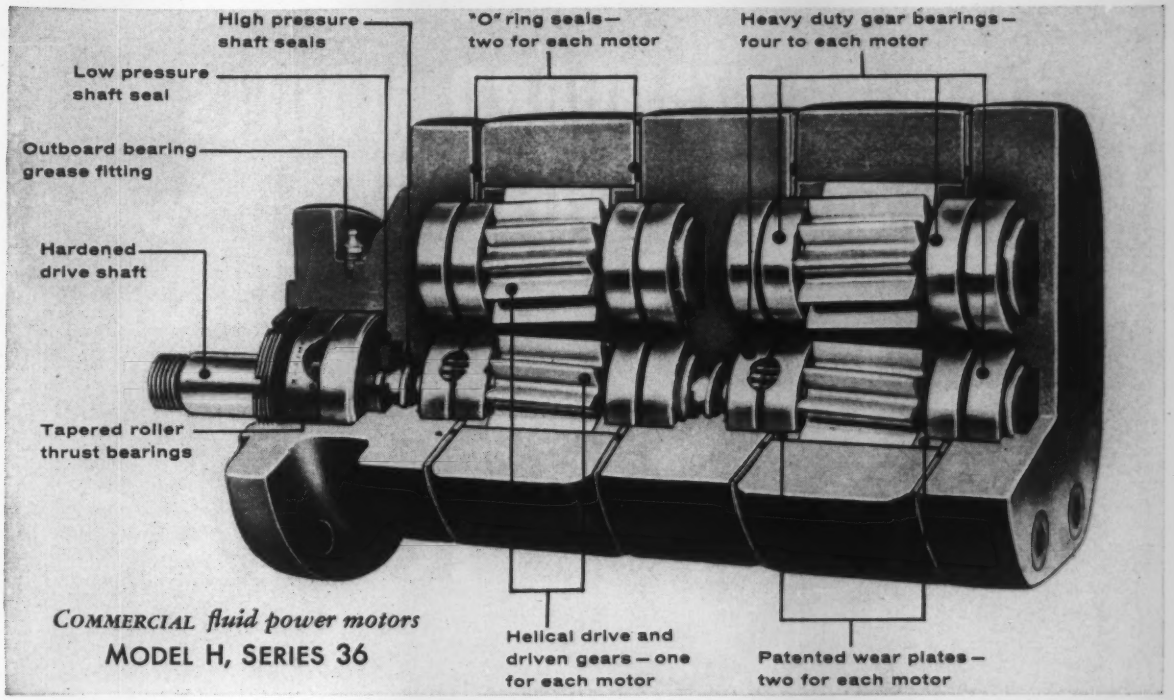
Color reversal film SO-260 is available for use in recording scientific and technical data under unfavorable lighting conditions. Having a normal ASA exposure rating of 160, film has been successfully exposed at indexes to 500. Exceptional speed, combined with adequate sharpness, grain pattern, and color reproduction, makes film suitable for all types of instrumentation recording. Tungsten-balanced film, color reversal Type B, SO-270, with normal index of 125, is also available. This film has been successfully exposed at indexes to 375. Both films are available in 16, 35, and 70-mm sizes. **Photo Recording Sales Div., Eastman Kodak Co.**, Rochester 4, N. Y. N

Circle 829 on Page 19

Photocopying Machine

takes originals to 15 in. wide, any length

Champion photocopier exposure system insures sharp positive copies without fuzziness. Unit features simplified front-ejection system for



How to get multiple "speed-torque" output

Multiple-speed drive simplified

Efficient operation of heavy mobile equipment frequently involves multiple speeds. Not so efficient, however, is the shifting of gears, the power take-offs, clutches and gear transmissions involved in gaining these desired speed levels with mechanical drives—not to mention the constant maintenance headaches these same drives entail.

Pictured above is one Commercial fluid power oil-hydraulic motor that now delivers low and high speeds efficiently—completely eliminates the problems mechanical drives ordinarily involve.

Two motors work in tandem

This Commercial Model "H" tandem motor actually involves two single motors of equal output mounted on one common drive shaft. When fluid power from the pump source is directed by simple valving into just one of the single motors, the shaft rotates at the high speed. The other single motor on the same shaft receives no input and therefore merely turns. When low speed is required, the total fluid power delivery from the pump is valved into both of the single motors. And of course motor torque at this reduced speed is doubled. This simplified control of two speeds—both low and high—is possible in either direction, forward or backward.

Each of the single motors in this Model "H" tandem motor has one-inch gears. With a fluid power input of about 15 gpm at 1200 psi, for example, when one of the single motors receives the entire input, rotation is 1200 rpm. When the same input is split between the two equal size single motors, rotation is 600 rpm.

Model "H" motors are available with gears in widths of 1", 1¼", 1½", 2", 2½" and 3". Any combination of gear sizes is practical.

More than two speeds

Even three speed operation can be obtained with Commercial double tandem motors when gears of different widths are used in each single motor. High speed operation results when the full pump delivery is valved to the motor with the smaller gears, intermediate speed when it is all directed to the larger gear motor, and slow speed when valved to both motors. Commercial Model "H" motors are recommended for continuous duty operation at pressures up to 2000 psi and speeds up to 1800 rpm.

Engineering help available

Be sure to send for your copy of Commercial's "Oil-Hydraulic Motors Catalog H-4". Further information on Commercial's complete line of other fluid power components—valves, pumps and cylinders—is also yours for the asking, as is help and assistance from COMMERCIAL's technical service department.

Address inquiries to Commercial Shearing & Stamping Company, Dept. S-46, Youngstown 1, Ohio.

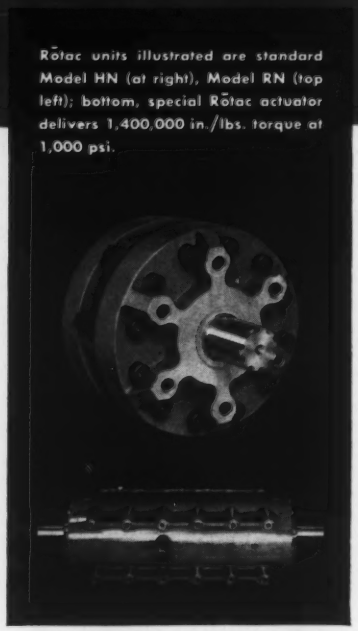
COMMERCIAL
shearing & stamping

Circle 615 on Page 19

From 26 STANDARD MODELS— 312 MODIFIED STYLES FOR DESIGN FLEXIBILITY!

RŌTAC

Reciprocating Rotary Torque Actuators



Rōtac units illustrated are standard Model HN (at right), Model RN (top left); bottom, special Rōtac actuator delivers 1,400,000 in./lbs. torque at 1,000 psi.

Rōtac gives greater design flexibility wherever you need *movement, instant torque, and a compact power package!* From 26 catalogued models you can draw on 312 "standard modifications"—to meet your special needs in size, torque, load, travel, temperature or operating pressure. Engineering service is available for unusual applications.

BRIEF RŌTAC FACTS—Torque ratings from 100 to over 200,000 inch-pounds. Single or double-end shaft, key or spline. Uses air, oil or fire-resistant fluids. Mounts at any angle, singly or in manifold installations, with shaft or body rotating. Precise control of travel arc through 280 degrees. Construction to J.I.C. standards. Few internal moving parts and total absence of external moving parts insures long life, trouble-free performance.

59-R-46

HOW CAN YOU USE RŌTAC?

Rōtac Actuators simplify design, production and maintenance in such industries as foundry and heavy machinery, precision machine tools, automated production equipment, marine, mobile and materials handling, paper, printing and plating. Here are some typical uses:

Continuous rotation • Lift—lower • Oscillate • Index—position • Screw clamp • Toggle—cam pushing • Load-unload • Transfer • Press • Intermittent feed • Turnover • Constant tension • Conveyor turn or stop

FREE DESIGN DATA BOOK—20 pages on how Rōtac works, torque ratings, control, dimensions, installation, typical applications and special uses. See your Rōtac Representative or write direct.

EX-CELL-O FOR PRECISION XLO

EX-CELL-O CORPORATION

GREENVILLE PLANT, 945 E. SATER ST.
GREENVILLE, OHIO

EX-CELL-O PRECISION PRODUCTS INCLUDE: MACHINE TOOLS • GRINDING AND BORING SPINDLES • CUTTING TOOLS • RAILROAD PINS AND BUSHINGS • DRILL JIG BUSHINGS • TORQUE ACTUATORS • THREAD AND GROOVE GAGES • GRANITE SURFACE PLATES • AIRCRAFT AND MISCELLANEOUS PRODUCTION PARTS • DAIRY EQUIPMENT

Circle 616 on Page 19

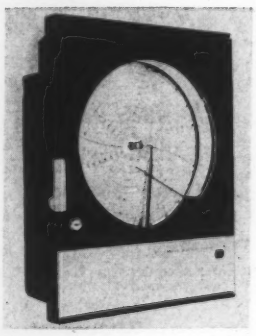
easy handling of finished copies, front slide-out developer tray to eliminate lifting or spilling, and improved exposure dial. Copier makes perfect black-on-white copies in seconds of any original up to 15 in. wide in any length, in any ink, ball point, crayon, or pencil. Original can be on any kind of paper, colored or opaque, or paper printed on both sides. **Copease Corp.**, 425 Park Ave., New York 22, N. Y. D

Circle 830 on Page 19

Twelve-Inch Recorder

for temperature or pressure

Redesigned 12-in. recorder incorporates up to four recording pens for measurement of temperature, pressure, or a combination of the two. Ball-pivoted pen movements minimize friction and wear. Filled-system thermometer elements measure temperatures from −300 to +1200 F, with fills including mercury, vapor, gas, and organic liquid. Pressures from 30 in. of mercury vacuum to 25,000 psi can be recorded. Elements include spiral, bellows, and C-type Bourdon tube. Rear of redesigned case has recessed bottom that permits one type of connection for both wall or panel mounting. Large opening in die-cast aluminum door improves visi-



Design Uniform lift into equipment with DUFF-NORTON WORM GEAR JACKS

Many designers find a ready answer to precise control of linear motion in machinery or equipment with built-in Duff-Norton Worm Gear Jacks.

They are used singly, in tandem and in multiple jacking arrangements to position loads weighing from a few hundred pounds to as much as several hundred tons.

When connected in tandem or groups of four, six or more, these jacks always raise or lower in exact unison regardless of load distribution. They are also used for application of pressure, to push or pull and as linear actuators.

Duff-Norton Worm Gear Jacks are self-locking and will hold heavy loads in position indefinitely without any creep. Since there is no fluid or air to leak, the action is always positive and maintenance is no problem.

These jacks are available in eight standard models with capacities ranging from 2 to 100 tons and with standard raises from 6 to 24 inches. Special raises can also be furnished.

To learn more about how Duff-Norton Worm Gear Jacks may be used in your equipment, send for the bulletin which shows engineering drawings of jacks, Duff-Norton Mitre Gear Boxes and typical applications. Ask for AD-66v.

DUFF-NORTON COMPANY

P. O. Box 1889 • Pittsburgh 30, Pennsylvania

COFFING HOIST DIVISION • Danville, Illinois

DUFF-NORTON JACKS

Ratchet • Screw
Hydraulic • Worm Gear

COFFING HOISTS

Ratchet Lever • Air
Hand Chain • Electric

Circle 617 on Page 19

SPECTROL PRECISION MECHANISMS

The Big Squeeze Job

SPECTROL'S new PRECISION MECHANISM—a velocity servo—is more than just another interesting shrink job. It's useful. It can go anywhere you need an ultra-miniature, precision speed control device.

First, the package. It measures only 1½ x 1½ x 3 inches. In a space that would give a sardine claustrophobia, Spectrol engineers squeezed a solid-state amplifier, a servo-motor, a gear train, and a very special, condensed (½-inch long) potentiometer and switch.

The pot has four electrically isolated wipers, all riding 90° apart on the same coil. The switch, in the same pot housing, has four wipers riding on an alternately conducting and non-conducting surface.

THE FUNCTION: The servo accepts dc signals varying between ±10 v from a computer to drive the pot in such a manner that speed is directly proportional to the dc signals.

THE APPLICATIONS: Here's an example: tied to an airborne computer, the Spectrol servo will drive a scope in the cockpit of one of the nation's hottest aircraft. The object: to give the pilot a visual, three-dimensional analog of his position. Actually, the servo will drive anything—resolvers, synchros, tachs, other pots and switches. It's a complete, ready-to-go package you can put into your system as is.

This is another example of how Spectrol PRECISION MECHANISMS free the systems engineer from building functional subassemblies using components such as gear drives, clutches, precision potentiometers and servomotors. If you need modules combining any of these components in a *single specification*—Spectrol can help.

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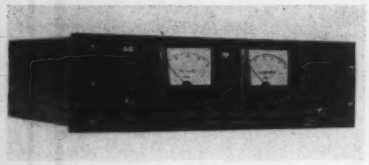
Circle 618 on Page 19

bility of recording chart. U. S. Gauge Div., American Machine & Metals Inc., Sellersville, Pa. E

Circle 831 on Page 19

DC Power Supply

has magnetic amplifier and transistor regulation



Model MTRO36-5 laboratory power supply has a dc output of 0-36 v at 0-5 amp. Unit combines fast dynamic response of transistors with reliability of magnetic amplifiers to provide dependable regulation of both line and load transients. Regulation circuit is designed to protect voltage-sensitive transistorized loads against damaging overshoots. Containing all-solid-state circuitry, supply has no vacuum tubes, brushes, vibrating contacts, or other delicate or moving parts. Dynamic line regulation is ±10 mv for step changes of 10 v between 105-125 v ac input. Dynamic load regulation is ±0.2 for step changes from no load to full or vice versa. **Perkin Engineering Corp.**, 345 Kansas St., El Segundo, Calif. L

Circle 832 on Page 19

Digital Printer

has solid-state electronic circuits

Compatible with all makes of solid-state counting equipment having a four-line, 1-2-2-4 binary-coded decimal output, Model 400C-T printer incorporates solid-state electronics. Printer uses transistorized plug-in drivers for each digit. Plug-in modules can be changed around to match a variety of outputs from transistorized equipment, adding to versatility of unit. Other features include four lines per sec printout, no stepping switches, parallel entry, and standard six-digit printout. Code-line input requires only 6 v. **Computer-Measurements Co.**, 5528 Vineland Ave., North Hollywood, Calif. L

Circle 833 on Page 19

TIPS AND TECHNIQUES

VOLUME I

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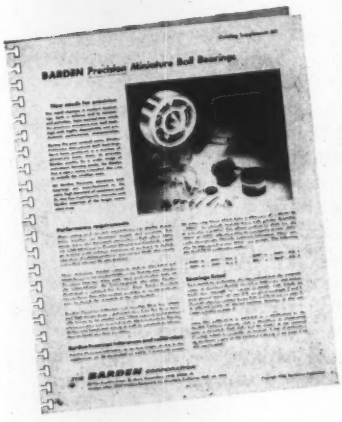

Precision-built computer gear trains must have uniformly low torque and minimum backlash; mounting surfaces for the bearings should be simple to manufacture.

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Circle 619 on Page 19

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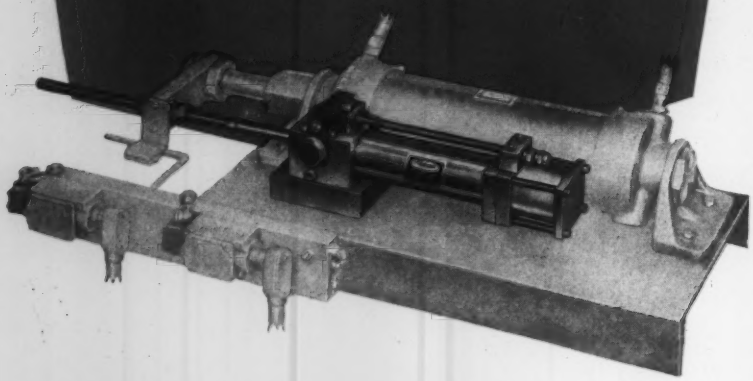

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Professional Viewpoints

. . . function or fad . . .

To the Editor:

In your editorial, "Function or Fad?" (MACHINE DESIGN, Sept. 17, Page 157), you state that "Suspicion always haunts the guilty mind" and "the nature of mind hasn't changed," and you draw a quite logical conclusion that "so long as that mind continues to be obsessed by fear and guilt, its owners will see a distorted vision of the rest of the world."

It seems to me that the further conclusion, "But exchanges of exhibits and delegations, and visits of top leaders, offer a hope that minds long closed by suspicion, ignorance, and prejudice can be opened" is a result of a slip in logic, because "suspicion always haunts the *guilty* mind," and Communist leaders and members of their party never will be free from the obsession of guilt and fear due to their steady programmed plot against the Free World and elementary human rights at their home. Therefore, neither exchanges of exhibits nor delegations will convert your Utopia (". . . the diversion of talent and energy now going into armaments could bring about competition in peaceful scientific and technical achievement the like of which the world has never seen") into reality.

Russia needs foreign help to become economically strong to mend her military Achilles' heel—the dissatisfaction of her own peoples and satellites. She wants a temporary appeasement to discharge herself and receive badly needed economical help from democracies. This is the only goal of present practices.

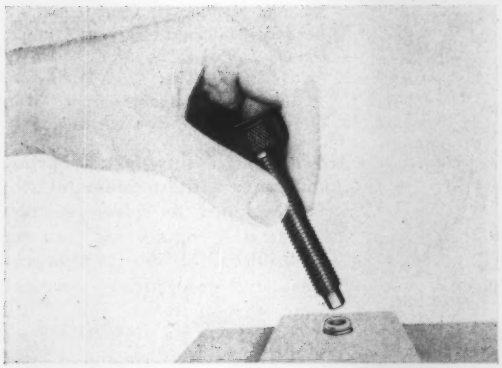
I agree with the remainder of your editorial except the statement, "They also appear to enjoy working." I have spent 26 years in Russia and 27 years in her neighborhood. Russians have correctly characterized themselves by two expressions which, translated, mean *may be* (perhaps) and *somehow*, and these expressions are still true despite 40-odd years of communism.

—J. H. INVEISS
Houghton, Mich

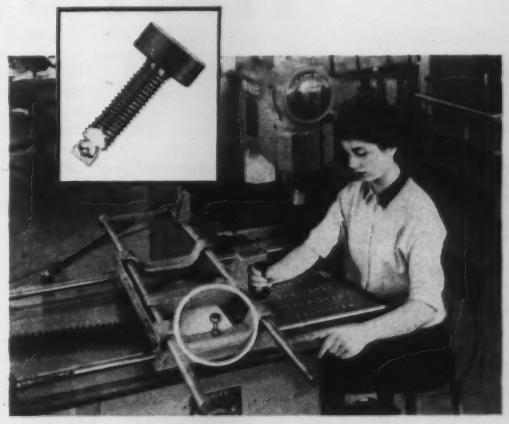
Practical Design Tips

No. 3 of a series

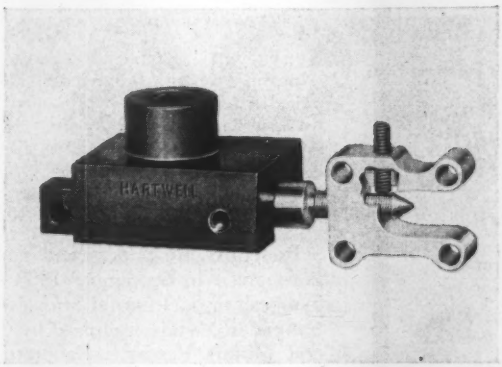
Perhaps the applications shown below will suggest ways you can profit from the use of Vlier tools. Many companies have simplified product design—with resultant savings—by substituting these simple, off-the-shelf items for complicated custom devices.



TO LIMIT TORQUE APPLIED TO SOCKET SET SCREWS grind the screw end of a Vlier Torque Thumb Screw to the proper size hex. The amount of torque can be quickly adjusted between 10 lbs. and 125 lbs. Once set torque is reached, knurled ring spins freely, preventing overtightening. Backing off is positive.



TO SECURE THE DUPLICATOR CARRIAGE of this metal fabricating machine when not in use, the manufacturer uses two Vlier Swivel-Pad Torque Thumb Screws. These simple holding tools with the unique ball-joint pad construction, limit the amount of torque which can be applied, and prevent scoring or damage to the ways. Vlier Swivel-Pad Torque Thumb Screws such as used in this application are available in various sizes and end pressures.



TO PROPERLY POSITION THIS YOKE-SHAPED PART for entrance into a latch assembly, a Vlier S-58 Spring Plunger is used. The threaded stud, extending horizontally, is slotted on two sides. As the stud is rotated, the spring plunger snaps into the slot assuring the proper position of the yoke. Vlier Spring Plungers are available in six nose types; various end pressures.

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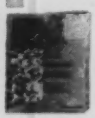

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THE ENGINEER'S Library

Recent Books

Engineering Thermodynamics. *By D. B. Spalding and E. H. Cole, University of London; 375 pages, 5¾ by 9 in., clothbound; published by McGraw-Hill Book Co. Inc., 330 West 42nd St., New York 36, N. Y.; available from* MACHINE DESIGN, *$8.50 per copy postpaid.*

Although this text is primarily concerned with fundamentals, theory is developed to solve examples of practical engineering problems. Definitions of work, temperature, heat, and properties of systems precede introduction of the First Law and its steady flow application. Steam as a typical fluid is used for most examples. The Second Law and Planck's formula permit study of maximum work output of machines. Absolute temperature and entropy chapters provide quantitative analysis of noncyclic and cyclic processes. Boyle's and Joule's laws are introduced for a final treatment of ideal gases.

Internal Stresses and Fatigue in Metals. *Edited by Gerald M. Rassweiler and William L. Grube; 451 pages, 6½ by 9½ in., clothbound; published by Elsevier Publishing Co.; distributed by D. Van Nostrand Co. Inc.; available from* MACHINE DESIGN, *$11.00 per copy postpaid.*

Presented are papers and discussions given in September 1958 at a Symposium on Internal Stresses and Fatigue in Metals organized by General Motors Research Laboratories. Internal stresses and fatigue are considered from the viewpoints of both the physicist and the engineer. The degree of interrelation between the two phenomena is demonstrated. After internal stresses are investigated, lattice strains and defects are discussed. Fatigue is then introduced and related to internal stresses in the metal structure.

Practical Design of Sheet Metal Stampings. *By Federico Strasser; 175 pages, 6 by 9¼ in., clothbound; published by*

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Chilton Co., 56th and Chestnut St., Philadelphia 39, Pa.; available from MACHINE DESIGN, $10.00 *per copy postpaid.*

Originally collected for lecture courses, material in this reference book has been revised and enlarged to agree with the present state of the art. Theoretical explanations are avoided. Practical information which has proved correct in actual work is presented. Major press-working processes are described and principles of good stamping design are established. Design details are then covered. Special problems encountered in metal stamping are also discussed.

New Standards

NEMA Standards. *Publications listed below are 8½ by 11 in.; paper covered; stapled; and available from National Electrical Manufacturers Association, 155 East 44th St., New York 17, N. Y.*

SG 8.1-1959. **Pressure Connectors for Copper Conductors—Compression Type.** 12 *pages;* $0.30 *per copy.*

SG 8.2-1959. **Pressure Connectors for Copper Conductors—Screw Type.** 13 *pages;* $0.30 *per copy.*

Covered are pressure connectors, including electrical connectors used to terminate or join electrical conductors, which are installed by mechanically applied pressure and without the use of solder. Compression type connectors undergo a change in size or shape as a result of the external pressure required to fix the connector to the electrical conductor. Screw type connectors are fixed to the electrical conductor by pressure from integral screw, wedge, or other mechanical parts.

Test methods are described and values given for secureness, temperature rise, and pull-out strength. Construction details specify identification, material, finish, method of assembly or tightening, and dimensions.

IC 1-1959. **Industrial Control.** 160 *pages,* $6.00 *per copy.*

Superseding IC 1-1954, this standard has been revised and rearranged. Practical information is provided on construction, test, performance, and manufacture of industrial control equipment. Standards cover contactors, control re-

lays, resistors, autotransformers, reactors, static switches, pushbuttons, motor-starting switches, time-delay relays, and brakes. General purpose ac and constant-voltage dc controllers are included. Definite-purpose controllers are listed for steel-mill machinery, cranes, mine hoists, compressor units, automatic oil-field equipment, and graphic-arts machinery.

Government Publications

NASA Technical Notes. Copies of publications listed below are available from Office of Technical Services, U. S. Dept. of Commerce, Washington 25, D. C.

TN D-4. Influence of Shaft Deflection and Surface Roughness on Load-Carrying Capacity of Plain Journal Bearings. By F. H. Raven and R. L. Wehe of Cornell University; 54 pages, 7¾ by 10¼ in., paperbound, side-stapled; $1.50 per copy.

Experimental data and analysis prove that load capacity of a bearing with a flexible shaft may be predicted. Shaft deflection and roughness of bearing surfaces are shown to be prime factors in limiting load capacity. Based on criteria presented, optimum length-diameter ratio of the bearing can also be predicted.

TN D-111. Fatigue Strengths of Aircraft Materials. By H. J. Grover, W. S. Hyler, and L. R. Jackson, all of Battelle Memorial Institute; 25 pages, 7¾ by 10¼ in., paperbound, side-stapled; $0.75 per copy.

Results are given of axial-load fatigue tests on edge-notched sheet specimens of 2024-T3 and 7075-T6 aluminum alloys and of normalized SAE 4130 steel. Notch root radii were 0.004 and 0.070 in. Specimens had a theoretical stress-concentration factor of 4. Tests were run at 0 and 20,000 psi nominal mean stress. Data indicate potential usefulness of Neuber's technical stress-concentration factor.

TN D-163. Handbook of Structural Stability. Supplement to Part III—Buckling of Curved Plates and Shells. By George Gerard, New York University; 23 pages, 7¾ by 10¼ in., paperbound, side-stapled; $0.75 per copy.

Recent results on buckling of curved shells are reviewed and interpreted in terms of analyses previously presented. Theoretical results are presented on plastic buckling of moderate-length circular cylinders under torsion and external pressure. Solutions have also been obtained for buckling of circular cylinders under torsion and external pressure by both the initial-imperfection and the finite-deflection - energy approaches. Experimental tests provide data on buckling of cylinders under external pressure and under combined internal pressure and compression.

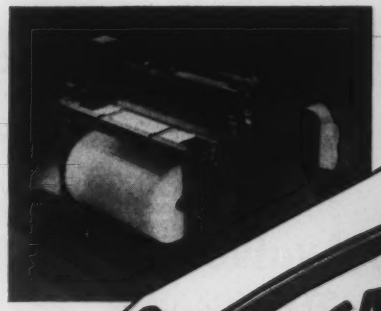
TN D-1. A Study of the Acoustic Fatigue Characteristics of Some Flat and Curved Aluminum Panels Exposed to Random and Discrete Noise. By Robert W. Hess, Robert W. Herr, and William H. Mayes, all of Langley Research Center; 41 pages, 7¾ by 10¼ in., paperbound, side-stapled; $1.25 per copy.

TN D-20. The Analysis and Design of Continuous and Sampled-Data Feedback Control Systems with a Saturation Type Nonlinearity. By Stanley Francis Schmidt, Ames Research Center; 106 pages, 7¾ by 10¼ in., paperbound, side-stapled; $2.50 per copy.

TN D-52. The Rate of Fatigue-Crack Propagation for Two Aluminum Alloys Under Completely Reversed Loading. By Walter Illg and Arthur J. McEvily Jr., Langley Research Center; 19 pages, 7¾ by 10¼ in., paperbound, side-stapled; $0.50 per copy. (Sheet specimens: 2024-T3 and 7075-T6.)

TN D-59. Investigation of Vibration Characteristics of Circular-Arc Monocoque Beams. By Wilbur B. Fichter and Eldon E. Kordes, Langley Research Center; 27 pages, 7¾ by 10¼ in., paperbound, side-stapled; $0.75 per copy.

TN D-108. Relationship of Polymer Structure to Thermal Deterioration of Adhesive Bonds in Metal Joints. By J. M. Black and R. F. Blomquist, Forest Products Laboratory; 35 pages, 7¾ by 10¼ in., paperbound, side-stapled; $1.00 per copy.



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Circle 625 on Page 19

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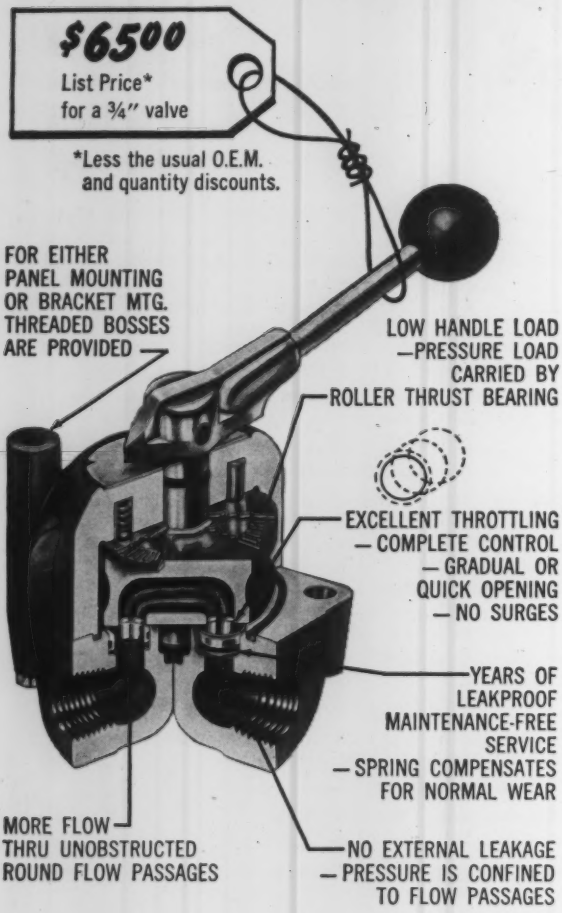

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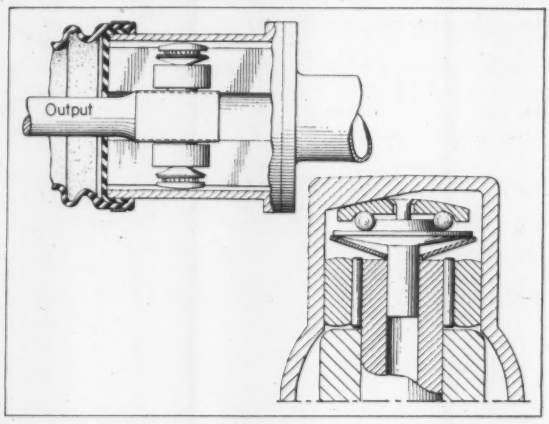
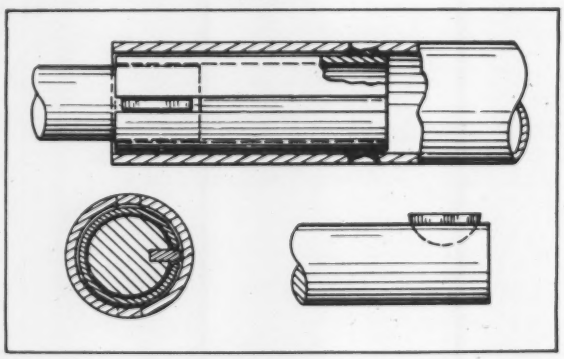
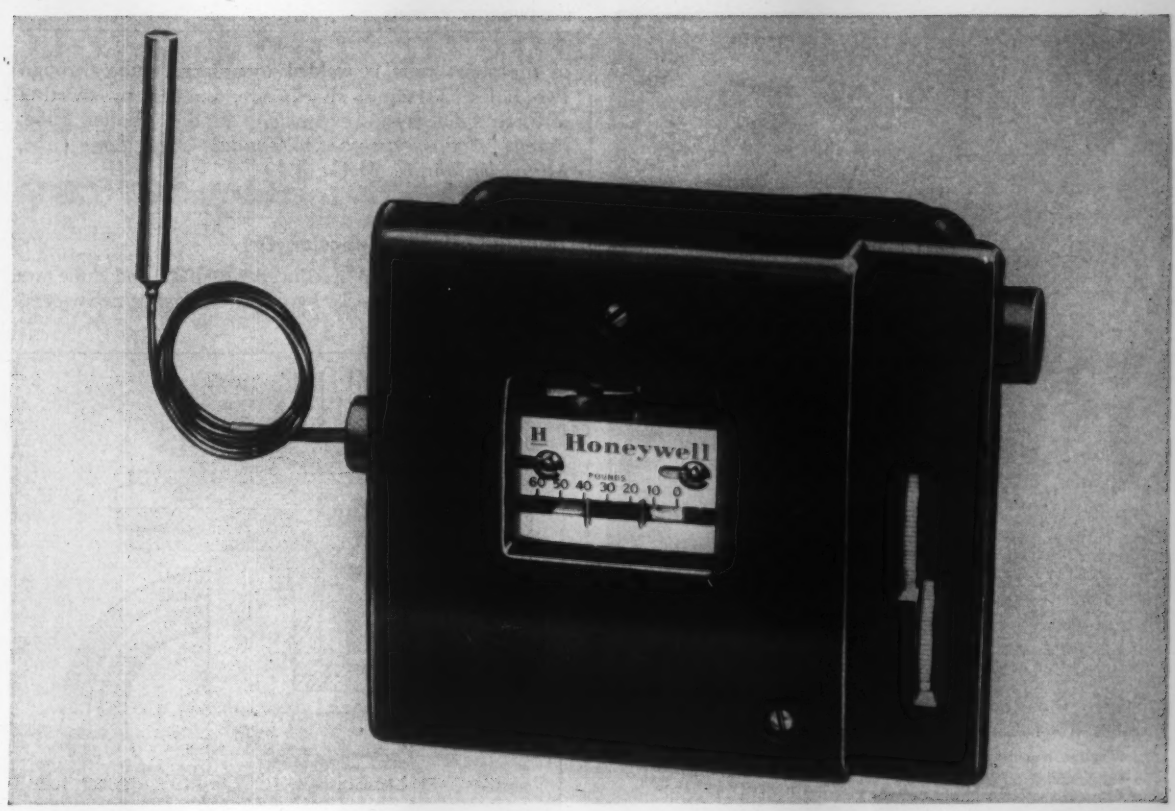


the trunnion shaft, perpendicular to the output shaft, bearing caps engage and help contain a ring of balls. Each assembly of balls and races is held against the joint casing by a belleville spring. A slope on the inside casing surface moves contact points off center to assure that the caps rotate instead of drag. Inboard of the cap assemblies, needle bearings assure free rotation of the output shaft. All bearings function during relative axial translation of the trunnion shaft. *Patent* 2,906,105 *assigned to General Motors Corp. by John Z. De Lorean.*

Torsional Shaft Coupling



Two telescoping tubes and a central shaft comprise a coupling which absorbs torsional shocks and permits limited axial displacement. The shaft carries a key which engages one end of a slot cut through the wall along the full length of a short tube. The other end



New Honeywell Temperature Controller for Industrial Applications

The new Honeywell T444 is a rugged, dependable temperature controller designed specifically for industrial use. It includes these features:

- Independent high and low temperature set points.
- External adjustment of temperature set points.
- Control setting scale and mercury switch position clearly visible.
- Sensitive, liquid filled thermal system.
- Steel case adaptable for surface or flush mounting.
- SPST and SPDT mercury switch models.

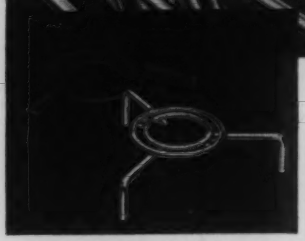
Get complete details from your Honeywell field engineer or write for specification 95-2437.

MINNEAPOLIS-HONEYWELL, 2753 Fourth Avenue S., Minneapolis 8, Minn.

Honeywell

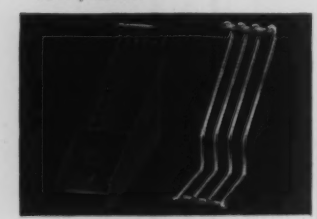
H HONEYWELL *First in Control*

Circle 627 on Page 19



Wire motor mount cut costs, absorbed vibration, reduced weight.

Wire/strip paddle arm for cleaning unit reduced costs 70%; ended noise problem.



Wire guide is lighter, easier to clean, much lower in cost.

Wire and wire/strip components improve the quality, efficiency and appearance of finished products.

CUT COSTS
Wire and wire/strip components save on tooling, machining, and materials.

Improve Design
Wire and wire/strip are strong and light; welds are stronger than parts joined.

Modern Look
Wire and wire/strip offer functional, decorative values. Finishes include Lustre-Zinc® (also available in attractive colors), nickel, chrome, brass, cadmium and electropolished stainless steel.

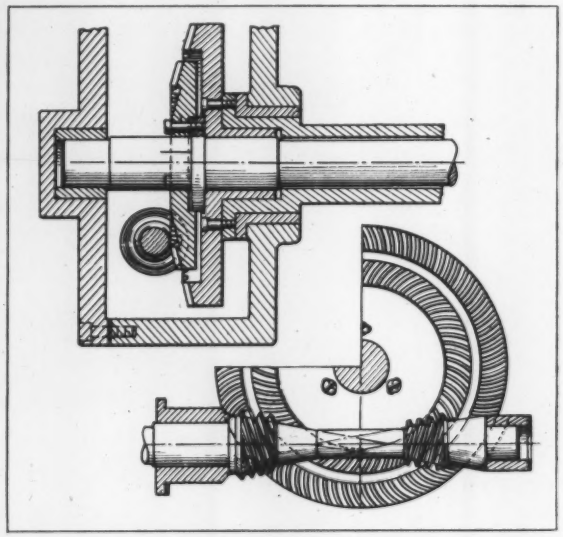
Free Package
Send now for our Wire/Strip component design package. New handbook describes complete production facilities for fabricating wire forms, welded wire and strip assemblies, light stampings and staples.

E. H. **Titchener**
AND COMPANY
65 CLINTON STREET, BINGHAMTON, NEW YORK

of the short tube is welded to a larger tube through two holes. Torsional shocks are damped by twisting and circumferential expansion of the smaller tube. *Patent 2,906,108 assigned to Vandale Corp., Long Lake, Minn., by John M. McCann.*

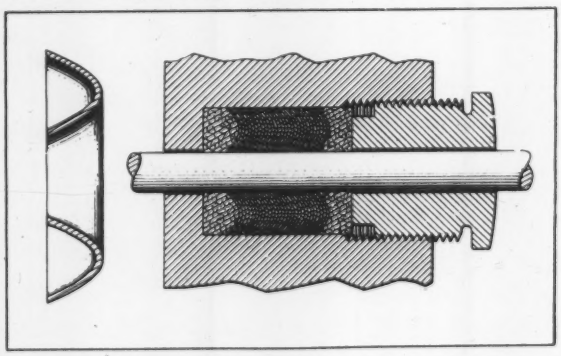
Double-Output Reduction Drive

Two outputs from a concentric shaft and tube are provided simultaneously by a device having two worms



on a single shaft, engaged with two concentric worm wheels. Outputs are in opposite angular directions and can be arranged to have the same or different speeds. Fabrication errors between the two wheels are accommodated by elongated screw holes in the smaller wheel. *Patent 2,908,187 assigned to Illinois Tool Works, Chicago, by Oliver E. Saari.*

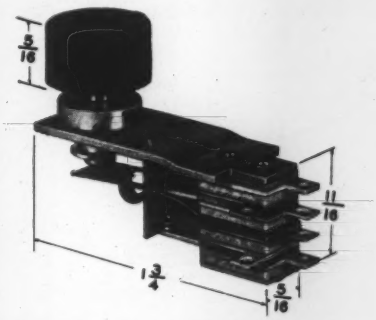
Metallic High-Temperature Shaft Seal



Nested wafers of aluminum foil comprise a shaft seal effective at temperatures of 500 F to 1000 F, and relatively insensitive to effects of radioactivity. Foil thickness can be 0.002 to 0.005 in. Regardless of the num-

Does your product design specify an open blade switch in multi-pole variations . . . in a minimum of space?

Acro's open blade switches as small as 15/64" x 9/16" x 13/16" adapt to an infinite number of precision snap action applications

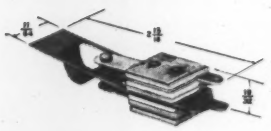


PUSH BUTTON (216-0030-00)

Small, compact, double pole, double throw switch, push button actuation. Designed for panel mounting — carries a 10 amp load.

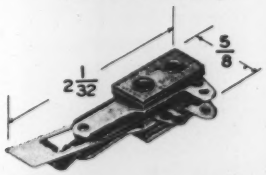
• Yes . . . high adaptability is a feature you'll like in Acro switches. Choose your own housing and any number of components . . . when you specify Acro's open blade switches. You'll get absolute minimum size with high electrical rating in an infinite variety of combinations. Versatile Acro open blade switches can be stacked and can also be adapted to set or return operations. The high adaptability of Acro's open blade switches will solve more of your product design problems.

LARGE ECONOSNAP (E-A1POBD-R)



Carries 25 amp load! Compact, low cost. Multi-pole construction available, as well as screw construction. Can be provided with roller or nylon button for main blade.

SMALL ECONOSNAP (E-S1POBD-R)

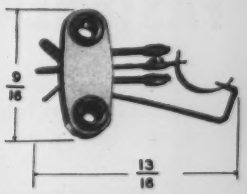


Available in return and set types, can be made with screw construction. A roller or nylon button can be added to main blade if desired. Multi-pole versions also available. Ratings: UL inspected — 15 amps, 125 volts AC — 7.5 amps, 250 volts AC — ½ H.P., 125-250 volts AC.

MIDGET ECONOSNAP (ME-S1POBD-R)

A compact, low cost, single pole, double throw switch. Long life assured, carries a 10 amp load. Has beryllium copper and stainless steel spring members and fine silver contacts. Roller or nylon button can be added to main blade. Multi-pole versions available. Choose from set or return type action. Rating 10 Amps, 125 Volts AC.

MODEL M-OM (M-2MOBD-RB)

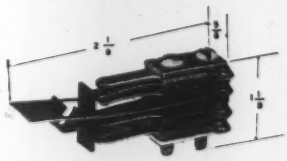


Here's a real sub-miniature switch — extremely small in size, with an unusual configuration that makes it a real space-saver. Carries a 3 amp load at 125 VAC. Can also be ganged for multipole circuitry.

MODEL M-OB (1MOBD-R)

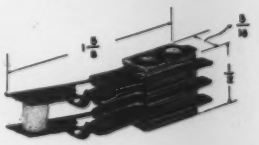
Very small size, requires minimum space, yet carries 12 amp load. Multi-pole construction available. Main blade provided with insulated extension if required. Designed for long electrical and mechanical life. Rating: UL inspected 12 amps, 125 volts AC-6 amps, 250 volts AC.

SMALL MULTI-POLE (S2-POBD-R)



Has beryllium copper and stainless steel spring members and silver contacts. Provided with side solder terminals. The laminations are held in assembly by two 6-32" screws. Carries a 15 amp load, 125 volts A.C.

MIDGET MULTI-POLE ECONOSNAP (ME-S2POBD-R)



Ideal for economical and positive control of two circuits. Choice of return or set type. Rear terminals. Laminations are secured by two eyelets which provide holes for mounting screws. Carries a 10 amp load, 125 volts AC.

• Take advantage of Acro's free engineering service. Whatever your switching problem, Acro will put its engineers to work on it. Just tell us what you want a switch to do, where it has to fit and how. No obligation of course.

Manufacturers of a complete line of load-tested precision snap action switches and relays.

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GRIPCO LOCK NUT
One piece all metal.

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Locking feature in the center for fast feeding. Can be applied from either end.

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With or without Gripco Lock. For application to metal too thin to thread or for inaccessible assemblies. Hex collar prevents turning when torqueing bolt.

GRIPCO PILOT-PROJECTION WELD NUT
With or without Gripco Lock. Centering collar positions nut and protects threads from weld spatter.

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With or without Gripco Lock. Countersink protects threads from weld spatter.

All types and sizes of Gripco fasteners listed in catalogue are available for immediate delivery.

Qualified fastener engineers are available for consultation on all your assembly problems.

Other Gripco Products:

- BRASS GRIPCO OR CENTERLOCK NUTS.
- MINIATURE WELD AND CLINCH NUTS, WITH OR WITHOUT LOCK.
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- STANDARD SEMI-FINISH FULL AND JAM NUTS.
- STAINLESS STEEL LOCK, WELD AND SEMI-FINISH NUTS.
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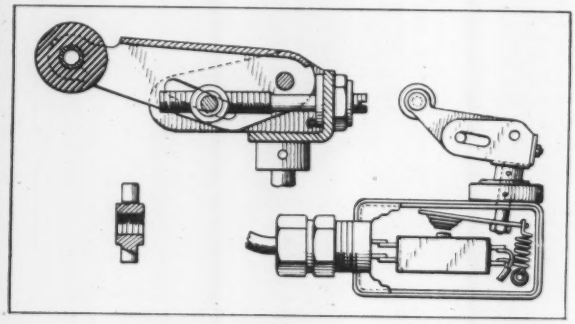
ber of layers, complete nests are punched out in assembled form. Tolerances on the dimensions of the seals can be liberal because the ductility and malleability of the metal enable the seals to fill packing recesses. *Patent* 2,903,281 *assigned to General Electric Co. by Howard W. Avery.*

Adjustable Switch-Actuator Arm

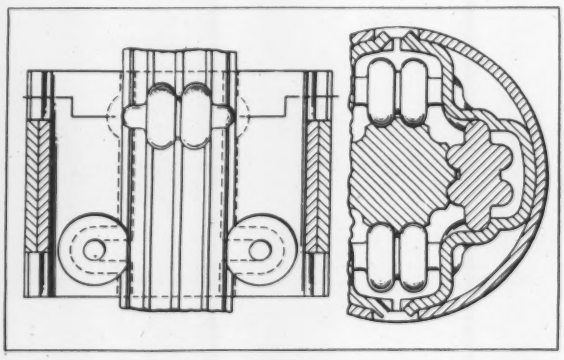
Fine angular adjustments, to a maximum of 15 deg, are provided by a compound actuator arm in a miniature switch. One member, fixed to a lever shaft, has



slots in its parallel walls, and carries an adjusting screw and a pivot pin. A second member, which carries a roller follower, has slots inclined to those in the first. It nests into the first member and pivots about the pin during adjustment. Settings are fixed by a threaded block which rides the adjusting screw and has pins engaging the slots in both nested members. *Patent* 2,906,842, *assigned to Electro-Snap Switch & Mfg. Co., Chicago, by Kacil C. Brin.*

Antifriction Linear Bearing

Design of an antifriction bearing assembly enables axial translation and prevents relative rotation between



a shaft and adjacent members. Bearing elements, shaped like paired wheels, roll in grooves in the central shaft. Axles, integral with the rollers, project into a two-part cage. At the ends of the cage halves, lips project into slots in an outer ring. *Patent* 2,907,610 *assigned to the Anderson Co., Gary, Ind., by Ralph H. Wise.*

Announcing a major breakthrough in computer programming.

If you've learned algebra, you can learn LGP-30 programming in just one day with

ACT 1

Algebraic Compiler and Translator

LGP-30

Electronic Digital Computer

The simplest, most economical compiling routine yet developed, ACT 1 now joins with the powerful Royal Precision LGP-30 to give you an unbeatable combination – low-cost, versatile general purpose electronic computation *and* programming.

With only a basic knowledge of mathematics, you can teach yourself ACT 1 in a single day. You can then submit any problem to the computer in simple algebraic form.

ACT 1 translates from a language you know into the machine language of the LGP-30. ACT 1 need not remain in the LGP-30 at compute time–giving you the entire computer memory (4096 words) for useful calculation. Both compiling and computing times are very rapid. Because the machine language program is punched on tape, it can be automatically brought into the computer whenever required.

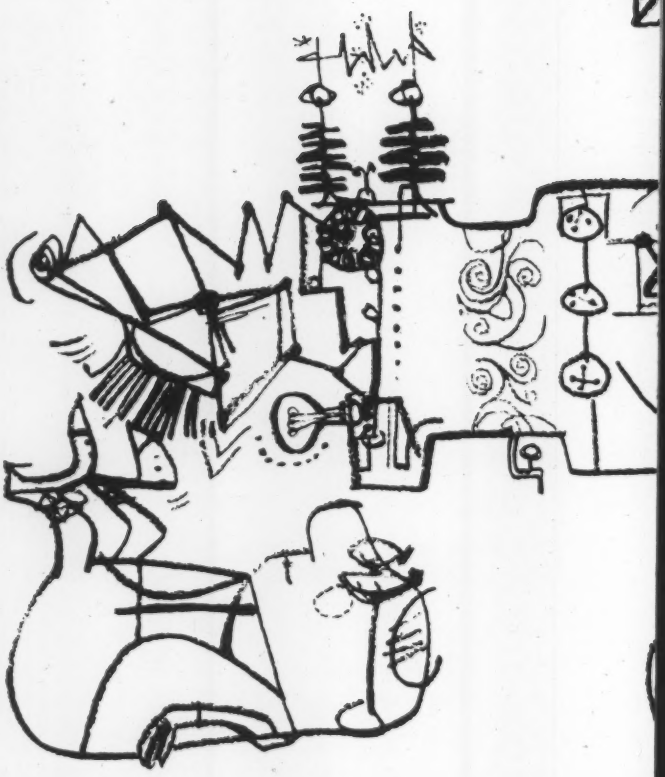
Capable of compiling a fixed and/or floating point program for the LGP-30, ACT 1 vastly reduces programming time, gives you final solutions *faster than ever!* It is by all odds the simplest compiler to learn *and* to use.

We will be happy to send you the ACT 1 compiling routine free of charge. Write today to Royal McBee Corporation, Data Processing Division, Port Chester, New York.

Royal Precision Corporation

Royal Precision is jointly owned by the Royal McBee and General Precision Equipment Corporations. LGP-30 sales and service are available coast-to-coast, in Canada and abroad through Royal McBee Data Processing offices. For complete information on the LGP-30 write **ROYAL McBEE CORPORATION,** data processing division, Port Chester, New York

just how "special" is your motor application?



chances are an inexpensive Westinghouse standard fractional hp motor can do your "special" job

Your application could be a "special" one . . . special in performance demands—or even from the appearance standpoint. But does it really require a high-priced special motor? It's a good bet that a *Westinghouse standard* fhp motor will more than meet every requirement—*and do it at a big savings!* Inexpensive Westinghouse standard motors have been doing "special" jobs for years.

Call in your local Westinghouse sales engineer and have him check the job you have on the board right now. Perhaps all you're getting with a "special" motor is a "special" (higher) price.

Westinghouse offers a full line of completely standard 48- and 56-frame motors—"specially" designed to the very top of NEMA specifications to give super-standard performance. For the full story write: Westinghouse Electric Corporation, Mr. C. B. Jakes, Industrial Motor Department, Lima, Ohio.

Lower Price! . . . much lower.
Less Assembly Time! . . . on the production line.
No Replacement Problems! . . . for your customers.
Repair Facilities! . . . on almost every corner.
Sure Deliveries! . . . right from the shelf.

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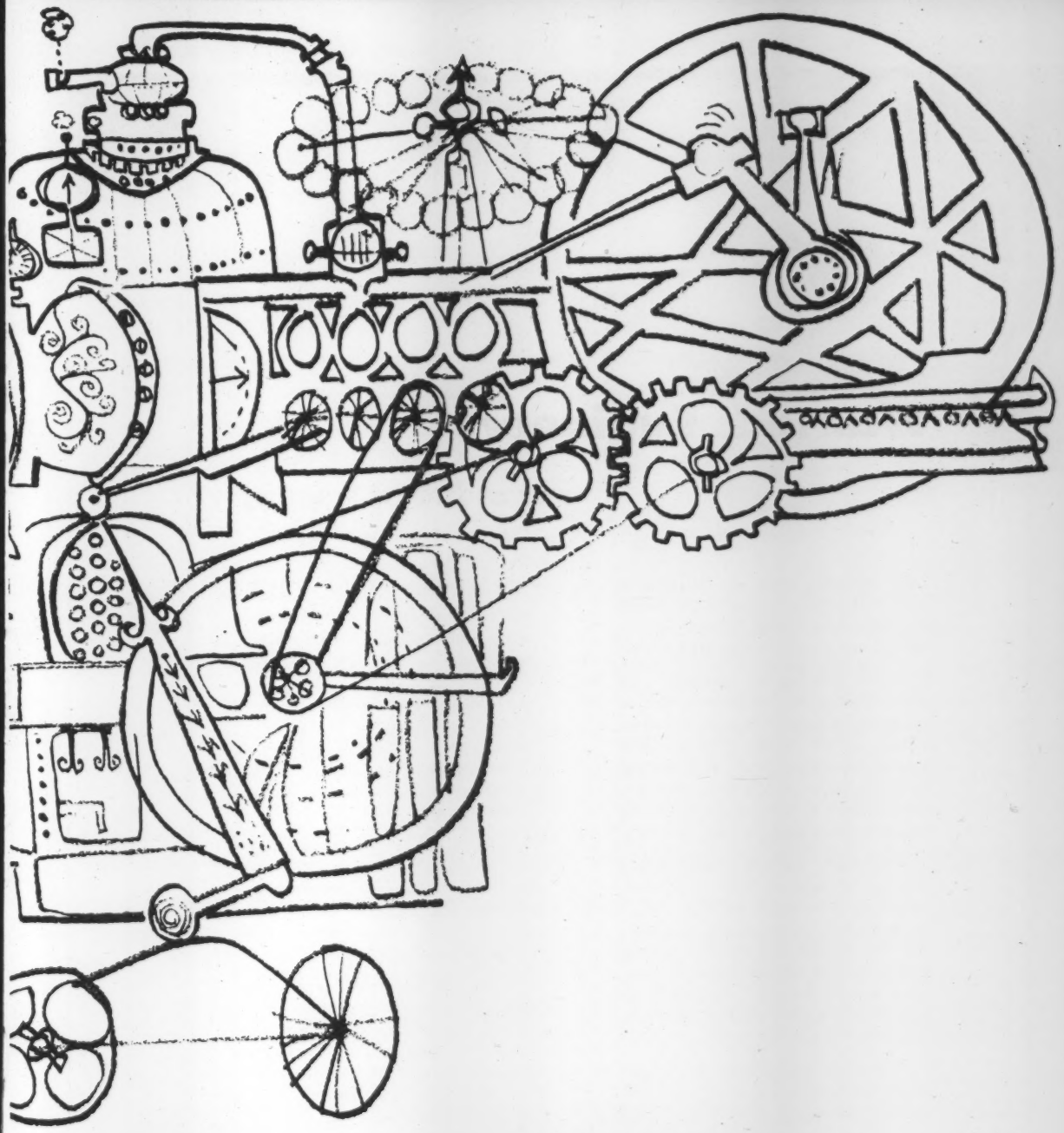

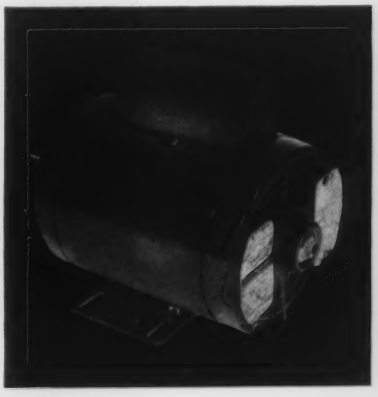

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Circle 632 on Page 19

Wanted: Engineers

with an interest in writing

Like to break into an interesting field where you'll make good use of your engineering talents — yet have a chance to develop new skills?

We're looking for several men with engineering experience and a yearning to write or edit. As an editor on MACHINE DESIGN, you would broaden your engineering background in a job that provides stimulating contact with people in many engineering areas.

You don't have to have actual writing or editing job experience, although we expect definite ability in handling the English language. An ME or EE degree plus several years of design-engineering experience would be ideal, but we'll be happy to consider equivalent qualifications. Age: 25 to 35.

If you've worked in a design-engineering specialty area, we'd like to hear about it. We're interested in any job experience or training in:

- Mechanical drives, controls, systems
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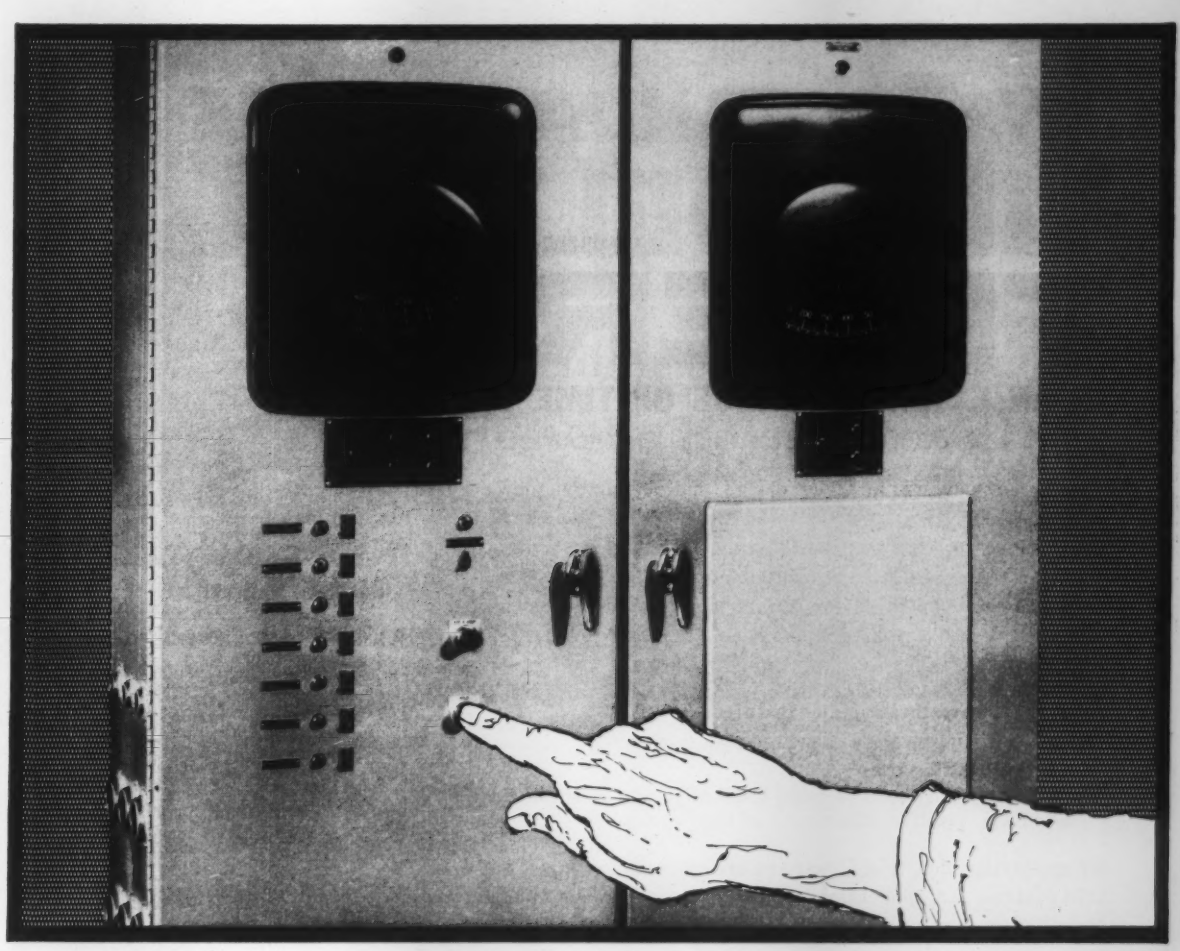
Our headquarters are in Cleveland. There is opportunity for travel to engineering meetings, expositions, and manufacturing companies. Salary will depend on your background and experience.

If you are interested, send a resume of your engineering background, and any evidence you may have of writing ability (we'll return this if you wish) to: Editor, MACHINE DESIGN, Penton Bldg., Cleveland 13, Ohio.

MACHINE DESIGN



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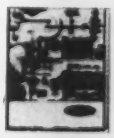
your product or process ever had

Makes no difference what kind of operating product or process you deal with—big, small, simple, complex—it's going to be judged on operation, and operation *alone*. For you won't always be on hand to make sure it is properly handled, properly controlled.

That's why your best insurance is a dependable automatic control system. It keeps efficiency at its peak and cancels out the high cost of human error.

How much does dependable automatic control cost? Depends of course on the requirements. But this you will find by actual comparison. Control Panel Corporation consistently comes up with the *best* price, the *better* design, and the fastest delivery whether it's J.I.C., NEMA, graphic or contour enclosures you want. And it's simply because panel manufacturing is our *only* business.

May we have the opportunity of submitting our quotation or proposal covering your requirements. There is no obligation, of course.



ASK FOR NEW BULLETIN

Lists Pantro uses and Pantro users. Shows a cross-section of the many types of automatic control panels Pantro has designed or built for industry of all kinds.

A Partial List of Pantro *Uses:*

- Chemical processes and machinery
- Bakery machinery
- Canning machinery
- Cement and clay working machinery
- Construction and road-building machinery
- Grain mill machinery
- Food processes and machinery
- Foundry machinery
- Machine tools
- Metalworking machinery
- Oil industry processes and machinery
- Paper processes and machinery
- Plastics molding machinery
- Printing trades machinery
- Power processes
- Rubber working machinery
- Special industry processes and machinery
- Textile machinery
- Woodworking machinery
- Conveying equipment
- Cranes, hoists, derricks
- Furnaces and ovens
- Hydraulic equipment
- Internal combustion engines
- Packaging and labelling machinery
- Railroad equipment
- Communications equipment
- Electronics equipment
- Motors, generators, motor generator sets
- Nuclear processes

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NOW 9 STANDARD TYPE TIME DELAY TIMERS

IN AN EXTENDED RANGE OF TIME CYCLES

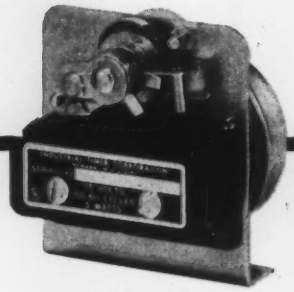
1/60th of a second to 24 hours

For bigger savings in OEM design and installation now, choose a standard time delay timer from Industrial Timer's expanding line to satisfy almost *every* mounting requirement... back, side, flush, through-the-panel, totally enclosed or explosion proof. Industrial Timer's bigger-than-ever selection gives you greater design latitude in both function and appearance... eliminates the need for costly custom-made controls in your specifications.

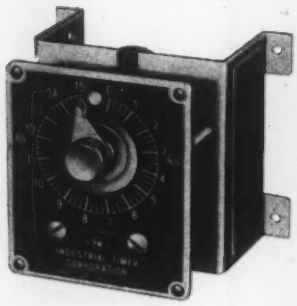
All 9 types have these special features:

1. Actuated by momentary *or* sustained pulse
2. Automatic reset
3. Heavy duty load switches rated at 10 and 15 amps
4. Easy, positive adjustment of time cycles

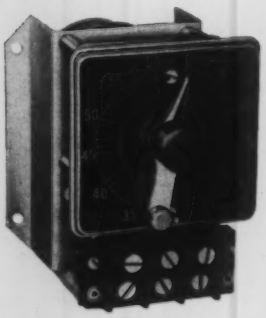
By specifying Industrial Timer you are assured of accurate and dependable controls for applications requiring a specific time delay between circuit operations. Full details in Bulletins 300, 800 and 900.



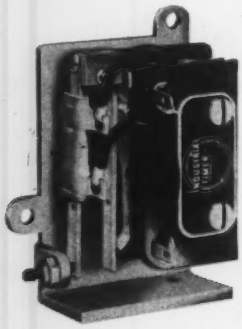
Series 90
Back-mounted, for applications where time cycle is infrequently changed or permanently fixed (½ sec. to 5 min.)



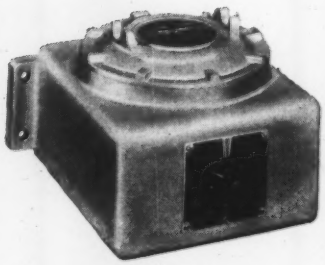
Series SF
Back-mounted (1/10 sec. to 5 min.)



Series TDAB
Flush-, back-mounted or totally enclosed (1/60 sec. to 3 hrs.)



Series TH
Back or bottom-mounted. Thermal time delay switch. (15 sec. to 2 min.)



Series TDXP
Bottom or back-mounted. Explosion proof. External adjustments (1/60 sec. to 3 hrs.)

Timers that Control the Pulse Beat of Industry

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Technical-ities

By John S. Davey

Quick facts on cold heading

Compared to machining, cold heading gives stronger pieces at less cost. Also, the headers automatically control quality because unsound material cannot be used. While the scope of cold headers is wide indeed, it pays to design for them right at the start.

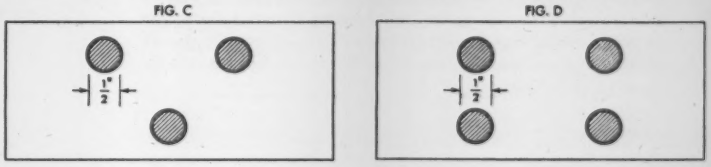
Some rules of thumb to guide you:

1. You save money after a run of 25,000 pieces (which pays for the set-up).
2. Maximum length of parts runs about 6 inches. Maximum volume of upset is equivalent to length of stock 4½ times its own diameter. (With special operations, up to 26 diameters have been achieved!)
3. Various metals and alloys are suitable. But keep carbon content in steel to under 0.45.
4. Concentric pieces are easier to form, though eccentric and serrated shapes are practical.
5. Avoid sharp corners. Allow generous radii.
6. Because upsets are usually cylindrical, oval or round shapes take less trimming than square or rectangular.
7. Hollow upsets tend to form cracks at edges of recess, so avoid them.
8. Embossing raises costs.
9. No problem heat treating short sections. But long sections are apt to be distorted.

When in doubt, contact an expert in cold heading.

How high strength fasteners affect the holes they fill

RB&W high strength fasteners, with a capacity close to or larger than the next larger size bright cap screw or machine bolt . . . PERMIT SMALLER HOLES . . . OR FEWER HOLES.



As simple a matter as the selection of fasteners can permit changes for better design . . . and also improve production costs and service life.

In sketch "A", for example, you see one difference from use of RB&W high strength fasteners instead of machine bolts or bright cap screws, as in "B". You use a smaller size fastener. Holes are therefore smaller. The metal section, in turn, can then be smaller for a saving in material and weight. The costlier the materials (copper bus bars as a case in point), the more significant the cost savings.

In sketch "C", fill the 3 holes with ½" high strength bolts, and you have a load capacity close to 40,000 pounds. That's the same as developed by 4 bright cap screws filling holes in Sketch D. It costs less to drill and less to fill the 3-hole design.

RB&W High Strength Fasteners are now identified by this new marking as well as 3 radial dashes. They have the proper balance between ductility and hardness required in high carbon units.

EFFECT ON PERFORMANCE AND PRODUCTION

When tightened to their full load, high strength fasteners not only *stay* tight—even under vibratory conditions—but also exert high clamping force. It has been shown that, under high compressive forces, hole areas gain extra resistance to fatigue cracks.

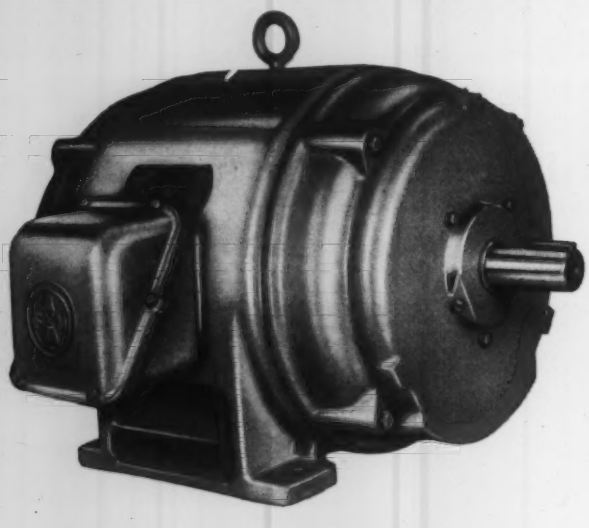
What's more, the high friction developed virtually locks members together, prevents slippage. Holes, therefore, need not be perfectly aligned since they can even be slightly oversized without detriment.

There's an RB&W Fastener Man ready to aid you in working with high strength bolts—in the design stage or as replacement for SAE grade 1 or 2 steel fasteners or for rivets. Write for helpful booklet DC-1, Russell, Burdsall & Ward Bolt and Nut Company, Port Chester, New York.

Plants at: Port Chester, N.Y.; Coraopolis, Pa.; Rock Falls, Ill.; Los Angeles, Calif. Additional sales offices at: Ardmore (Phila.), Pa.; Pittsburgh; Detroit; Chicago; Dallas; San Francisco.

Circle 635 on Page 19

Now—F-M Spiro-duct cooling!



Spiro-duct double-end system: In standard motor shown, air enters shaft end and discharges between feet on conduit box side of motor. Conversely, air entering free end discharges opposite conduit box. In motor with conduit box located opposite to standard position, direction of air flow is reversed in relation to drive shaft location.

Spiro-duct moves cooling air in clockwise spiral direction, through space between stator core and motor frame.

Cools entire core and winding regardless of direction of rotation!

From the research and development laboratories of Fairbanks-Morse comes Spiro-duct cooling—the most effective design available for positive cooling of Dripproof motors—available now in F-M rerated KZK motors, in frames 364U through 445U.

Two completely independent paths for cooling air are provided in the Spiro-duct double-end system. All portions of the stator core and winding are thus assured equal cooling, regardless of direction of rotation.

With completely redesigned and improved enclosure as well as ventilating system, Fairbanks-Morse offers an exceptionally cool motor with maximum protection against falling particles or dripping liquids.

For expert assistance in specifying, write Fairbanks, Morse & Co., 600 South Michigan Ave., Chicago 5, Illinois. Fairbanks-Morse motors include all types in alternating and direct current, in ratings from ½ to 10,000 HP.

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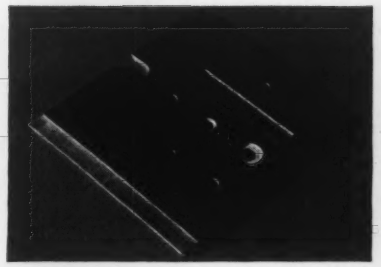
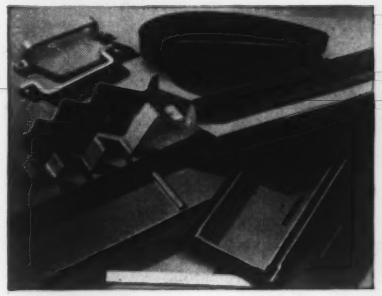
PRODUCT-DESIGN BRIEFS FROM DUREZ

- **Fire-retardant electrical laminates**
- **Plastic for wire-spring relay**



Plain . . .



or fancy

This electrical laminate deserves more than a casual look, if only because there are so many things you can do with it.

Made of glass-reinforced polyester, it comes in sheets or molded shapes that embody three useful attributes. First, they are strong enough to play a structural role in heavy-duty electrical equipment. Second, they retard fire. Third, their excellent electrical properties change but little at 100% relative humidity.

The shapes you see here are made with Hetron® polyester resin by Fiber Glass Industries, Inc., and are inherently flame-retardant. Hetron burns only in the immediate vicinity of an arc or hot flame, and quickly extinguishes itself when the heat source is removed. Thus in case of a burnout, damage is usually confined to a small area, with minimum effect on mechanical strength of the material.

Generally, Hetron laminates exhibit very low loss factor over a wide range of frequencies. Dielectric constant, for a ⅛-inch glass-mat laminate containing 35% glass, hovers as low as 4.25. Arc resistance of such a laminate is on the order of 110 seconds.

Do these traits suggest a way to achieve long life in equipment handling medium and high voltages? We'll gladly send you the complete data file on Hetron resins, and names of skilled fabricators who can supply laminates and molded shapes to match your ideas.

Building a better relay

Often it isn't enough to design a product. You may also have to find a way to make it.

Such was the case when engineers at Bell Telephone Laboratories developed for Western Electric Co. a new relay, basic component of telephone switching equipment.

In one swoop the new design—called the wire-spring relay—promised to reduce manufacturing and maintenance costs, work better, and last longer than its predecessor. However, this involved something that had never been done—molding straight wires into small plastic blocks automatically.

Before it could be done, Western Electric engineers had to:

1. devise a way to straighten small-diameter spooled wire;
2. feed the straightened wire into a mold in precisely spaced groupings;
3. embed the wires without shift in a molding compound that would insulate them and hold them securely for a relay lifetime of one billion operations or more.

Early in the game it became apparent that this was a job for phenolics. A major requirement was fast cure. Another was batch-to-batch consistency of the molding material. At fast cure speeds, a 10% variation in curing time can mean as little as 1.2 seconds' leeway between a reject and a good piece.

Volume resistivity was important. Could a Durez material handle the job?

Yes, one could. The wire-spring subassemblies you see here are made with it. They are being produced at low cost to the required accuracy in fully automatic molding machines. They prove the ingenuity of the men who developed this new concept in telephone switching—and the versatility that *you* command when you design with Durez materials.

To get a better idea of how far this versatility goes, check the coupon for more information. Booklets are available describing a range of properties you can get from typical Durez materials; give helpful suggestions on where to use them.

For more information on Durez materials mentioned above, check here:

- ☐ Data on Hetron, including fabricator lists (50-A)
- ☐ Durez molding compounds (14 page booklet)
- ☐ General information on Durez Products (Bulletin 400)

Clip and mail to us with your name, title, company address. *(When requesting samples, please use business letterhead.)*

DUREZ PLASTICS DIVISION

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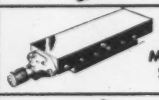
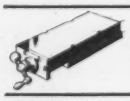
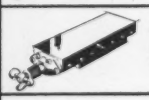
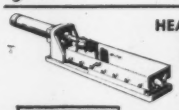
HEAVY DUTY BASIC TYPE

LIGHT DUTY TYPE WITH RETURN SPRING


HEAVY DUTY MICROMETER STOP TYPE


LIGHT DUTY LEAD SCREW TYPE


HEAVY DUTY LEAD SCREW TYPE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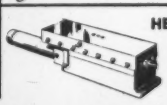
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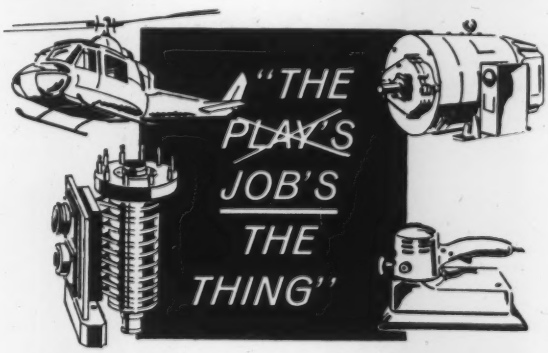

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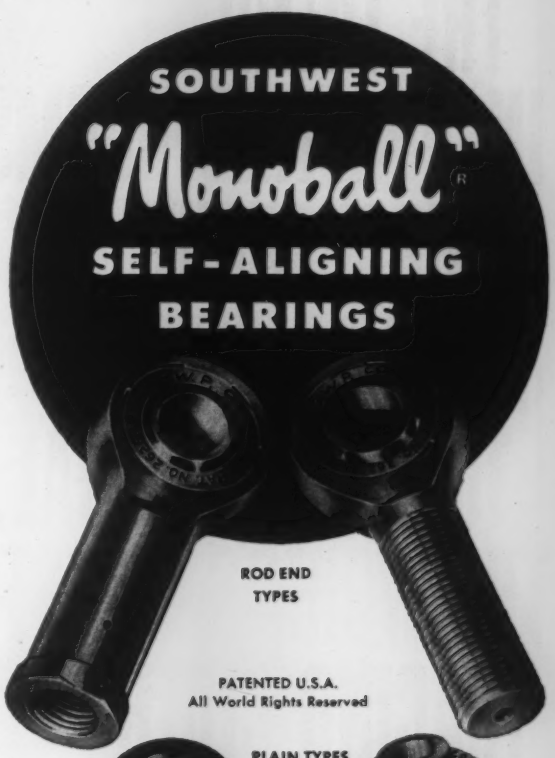

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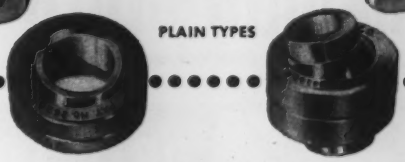

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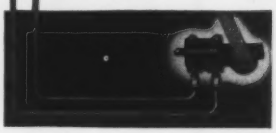

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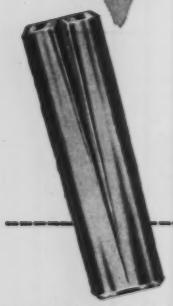

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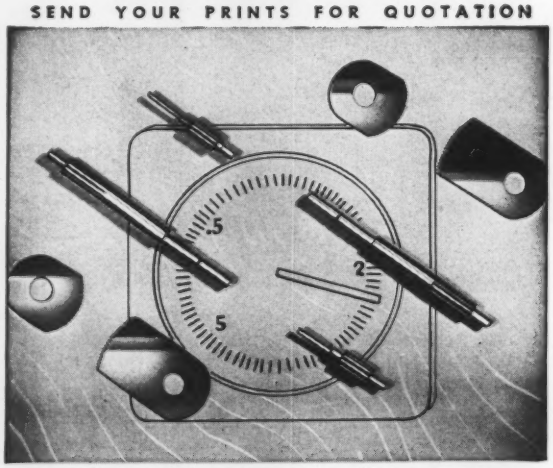

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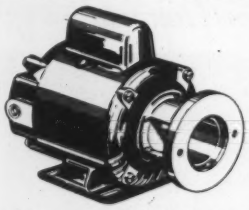

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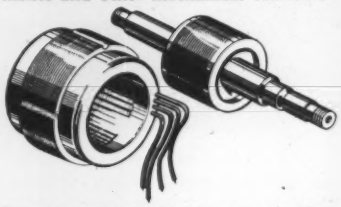

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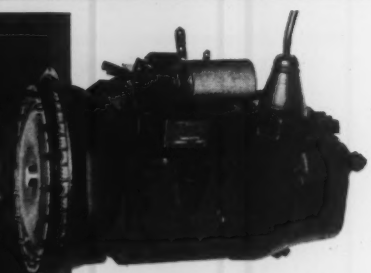

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Moore offers you a fast, dependable and economical source for one or a million

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Moore prices are right . . .
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	Headless Slotted	Square Head	Socket Head
Size (dia.)	#0 to ¾"	#6 to ¾"	#4 to ⅜"
Lengths	1/16 to 3"	3/16 to 2½"	⅛ to 1"
Points	cup, oval, round, flat, cone, dog		
Materials	steel, brass, bronze, stainless, aluminum, alloy steel, monel		

Special Heads — milled, slabbed, double slot, knurled.

Miniature Headless—#0, #1, #2, #3 sizes in a wide selection of metals, finishes, lengths and points.

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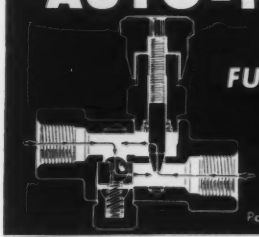
HYDRAULIC FULL FLOW VALVES



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A complete line: ⅛", ¼", ⅜", ½", and ¾" female Dryseal Pipe Sizes in all models and types. Equivalent Aeronautical Tube Sizes on special order.

MINIMUM PRESSURE DROP AND POWER LOSS . . . Oversize ports and passages give maximum flow at minimum pressure drop, insure greater accuracy and response in hydraulic or large volume air cylinder control.

EASY FLOW ADJUSTMENTS under full pressure. Seal located at port to eliminate air or dirt traps. Gland structure equally effective on pressure or vacuum.

SENSITIVE, CHATTERLESS BALL CHECK . . . Patented design insures rapid ball movement to open or close at low differentials.

FORGED BODIES permit higher pressures with wide safety margins. Aluminum—3000 psi; Steel and Stainless Steel—5,000 psi. Pressure ratings based on better than 5 to 1 safety factor. All internal parts are Stainless. Write for illustrated catalog.

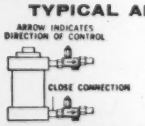
Model F Standard Flow Control Valve or Model N Needle Valve

Model KF Knob and Dial Flow Control Valve or Model KN Needle Valve.

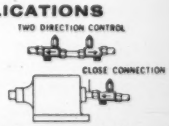
Model PF Knob and Dial Flow Control Valve or Model PN Needle Valve for panel mounting.

Model C Check Valve for In-Line Mounting.

TYPICAL APPLICATIONS



Controlling Double Acting Cylinder



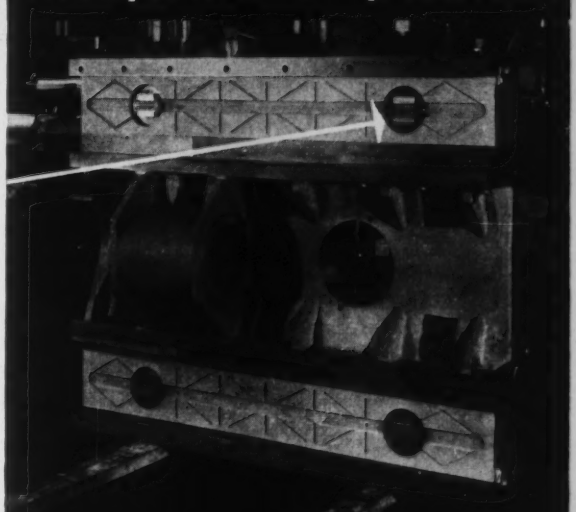
Controlling Single Acting Cylinder

AUTOMATION AUTO-PONENTS INC COMPONENTS

2925 GRANT STREET
BELLWOOD (Chicago Suburb) ILLINOIS

Circle 656 on Page 19

How to move heavy machine elements with less power, more precision

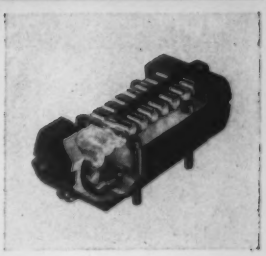


Roll them on Scully-Jones Tychoway Recirculating Bearings

If you make large machines or other equipment having heavy components that require accurate positioning, Scully-Jones Tychoway bearings can help you improve performance. They spread heavy, hard-to-move loads over a series of precision recirculating roller bearings, reduce starting and running friction (more than 90% less friction than with lubricated flatways).

Less friction means less power to start and maintain motion.

Another improvement comes from increased accuracy. Reduction of stick-slip, plus ability to maintain a more constant ratio between running friction and velocity, helped one manufacturer hold repeat positioning accuracy of .00015" on large tape-controlled machines. Benefits described above are even more apparent (and helpful) on manually operated equipment.



In many cases, Tychoway bearings eliminate costly hand fitting and special machining. All working parts are precision-machined from 52100 bearing steel, through-hardened to assure dependable, trouble-free service for the life of your machine. Made in five standard sizes, with static and dynamic load capacities ranging from 2,000 to 32,000 lb. Write for Bulletin 22-50.

SCULLY JONES

Scully-Jones and Company
1905 So. Rockwell St., Chicago 8, Ill.

Circle 657 on Page 19

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Since 1934 when the Indium Corporation was formed and produced the first commercial amounts of Indium, we have gained in knowledge and in service for all conceivable uses for Indium. Why not write us today . . . our quarter-century of technical knowledge is at your service.

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1676 Lincoln Avenue • Utica, New York

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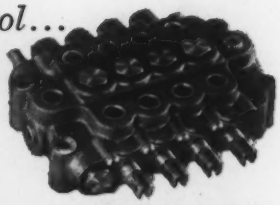
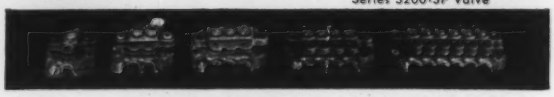
So Much Control...
So Little Space

HUSCO HYDRAULIC VALVES



HUSCO 4-Plunger, 45 G.P.M. Series 3200-SP Valve



- In ONE to SIX Plunger Designs
- For up to FOUR Control Positions
- Capacities from 3 to 185 G.P.M.

Other HUSCO features include:

- Power-Saving Pilot-Operated Relief Valve
- Short Plunger Movement for more accurate control — at minimum effort.
- Check Valve Controlled circuits — Conventional or Parallel.
- Compact, precision-built for minimum space.
- Over 120 Standard Models — for unlimited modification to your needs.

Check HUSCO *First* for Hydraulic Control. Write for your copy of HUSCO'S "House of Ideas in Control Engineering" — or design assistance on your needs.

HUSCO

HYDRAULIC UNIT SPECIALTIES CO.
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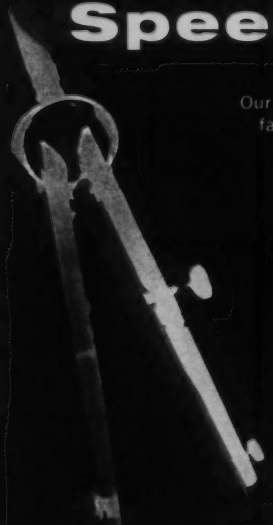
EASTMAN PACIFIC CO., Los Angeles, Calif.
ROY BOBBS AIR-DRAULIC CO., Portland, Ore.

Circle 659 on Page 19

DON'T BUY SUB-FRACTIONAL H.P. ELECTRIC MOTORS UNTIL YOU CHECK WITH

SpeedWay



Our modern manufacturing facilities and engineering know-how has saved hundreds of companies thousands of dollars annually. We want to work with you—for you—to design the quality motors you require and at your price. Write, wire or call for complete catalog.

Thor SpeedMotors

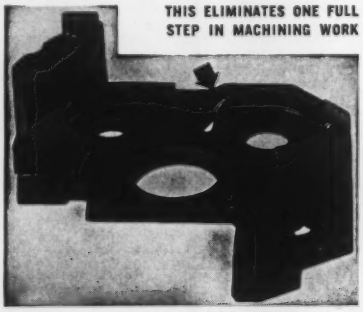
SpeedWay Mfg. Co.
Division of Thor Power Tool Co.
LaGrange Park, Ill.

Circle 660 on Page 19

he worries about small parts

he has his made by OPC

THIS ELIMINATES ONE FULL STEP IN MACHINING WORK



Just in case you think small parts can be too complex for OPC plaster mold casting, look at this one, of 356 aluminum, heat-treated to T-6 stage. Every plane, angle and curved surface is held to ±.005 tolerance where requested, and always within tolerances that require but a minimum machining time. Once an experimental project, this casting is now a production item, reordered regularly. Better send for our NEW brochure—you'll find it interesting and helpful.

OPC

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Plaster Mold Castings made from
BRASS • BRONZE • ALUMINUM • BERYLLIUM COPPER

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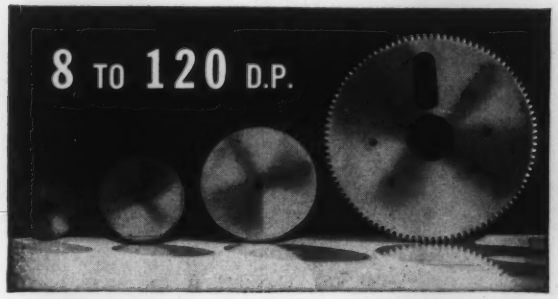

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ACCURATE STAMPED GEARS by *WINZELER* are BIG savers of time and money. Single stampings are laminated to wide faces at savings up to 60%! Further economies are made possible by a BIG range of *stock* Dies. Modern new plant, methods, and equipment now greatly increase production speed, efficiency and *economy!* Send blue prints. Tell us about your needs today. No obligation.

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WINZELER Stamped Gears

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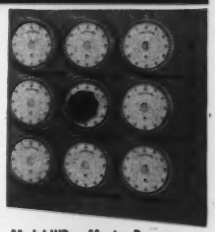
7355 W. WILSON AVENUE • CHICAGO 31, ILLINOIS

Circle 662 on Page 19

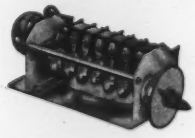
NOW . . . A New Design Concept in Multi-Circuit Program Control

ZENITH Multi-Circuit TIMERS



Model WD—Master Programmer

Master programming dials control operation of all circuits and sequencing relationship between circuits in the cycle. Adjustments are easily made on the face of the panel. As many as 48 "on" and "off" operations can be made on any one circuit without disturbing operation of other circuits. Single heavy-duty motor drives entire unit to assure full synchronization of operations and dials.



Model WM—Compact Design

Zenith Multi-Circuit Cycle Timers are available in models and types for all timing, mixing, compounding, processing and similar operations. They can be supplied in any time cycle and any number of switches.

Request details on the Zenith Master Programmer and other multi-circuit timers. Write on company letterhead for complete 64-page catalog describing automatic transfer and remote control switches, magnetic contactors, program clocks and timing controls.

See Classified Directory for Name of Local Representative

ZENITH ELECTRIC CO.
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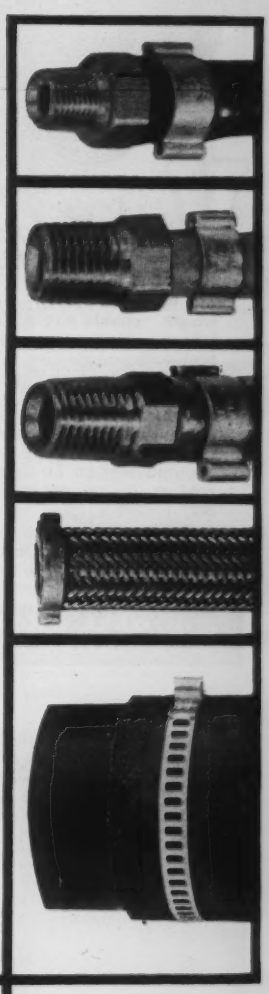
Circle 663 on Page 19

Circle Clamp

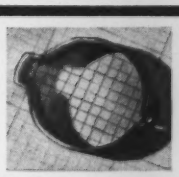
NEW FASTENER IDEA!

LOW IN COST

EASY TO APPLY AND REMOVE



Adapts Easily to Mass Production Applications.



Single-Lug, Mechanical-Loc Circle Clamp for Low Pressure Applications

- Large bearing surface
- Permits variation in hose O.D.
- Grips uniformly

Circle Clamps provide holding action equal to or better than any hose clamp available today. Write for complete descriptive information, stock sizes, prices and engineering aid.

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Cuyahoga Products Corporation
A subsidiary of RIC

Circle 664 on Page 19

NEW!

COLORFUL, LOW COST, PRECISION SHAFT TURNS COUNTER

VerniDial

The VerniDial H5850 is a lightweight, reliable and economical turns counter for accurately positioning multi-turn devices such as potentiometers, capacitors, valves and other equipment where micrometer readout of a setting is desired. Graduated in hundredths, it accumulates to 20 turns . . . reading or positioning from zero to 2000/100.

7 Colors (solid or combinations!): Black, Gray, Off-white, Yellow, Orange, Red, Green.

RESISTS CORROSION

INSULATES CIRCUITRY and BODY CAPACITY

COLORFUL for CODING and DESIGN

LIGHT WEIGHT MOLDED PLASTIC

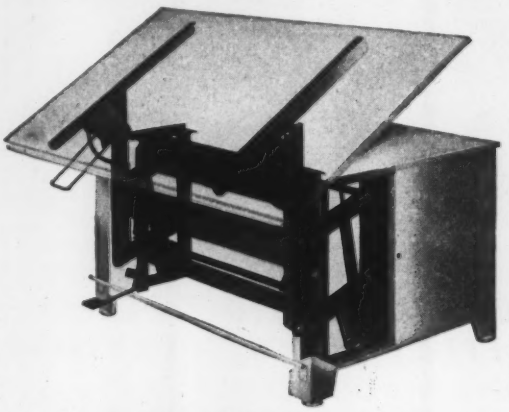
EASILY INSTALLED

Write for Bulletin H5850

HOWELL INSTRUMENT COMPANY
3101 Trinity Street, Fort Worth 7, Texas

Circle 665 on Page 19

MAYLINE



MAYLINE MAYLINE

The May-O-Matic Lifting Unit!

The May-O-Matic drafting table lifting unit controls top height and top tilt action. It counterbalances up to 55 lbs. weight added by drafting machine, etc.

The Mayline lifting unit is described in Folder F-25. Send for this and Folder S-22 on table combinations.

Mayline Company Inc.
601 No. Commerce St.
Sheboygan, Wisconsin

MAYLINE

Circle 666 on Page 19

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416-Page Catalog

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Subsidiary of **BENRUS WATCH COMPANY, Inc.**
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Circle 667 on Page 19

Buying Better Die Castings—No. 1

Paramount Die Castings Help Reeves Pulley Co. Make Variable Speed Drive

Three castings are supplied by Paramount to Reeves for the end shields and dial wheel on the Reeves Motodrive. ①

Size 100 Reeves fractional h.p. Vari-Speed Motodrive with infinite variable output speed from 2.86 to 4660 rpm. Size 100 is one of a full line of Reeves Motodrives for speed control on ¼ hp. through 40 hp. ② ③

Paramount can help solve your design and production problems.

If you use die castings, it pays to investigate Paramount's complete die casting service. Their designers, sales engineers, and modern tooling and production facilities offer you an ideal die casting service.

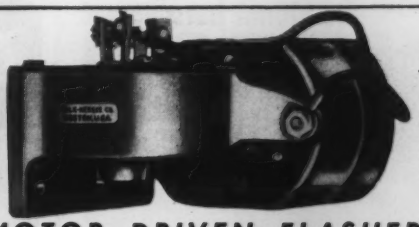
Zinc, Aluminum and Magnesium Die Castings

SEND FOR THIS HELPFUL BROCHURE . . .
A guide to Designing for Die Castings and a visit to Paramount.

Paramount DIE CASTING CO.
A Subsidiary of Talon, Inc.
ST. JOSEPH, MICHIGAN

Circle 668 on Page 19

Cole-Hersee



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COLE-HERSEE CO.
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Circle 669 on Page 19

Lepel

HIGH FREQUENCY *Induction* HEATING

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LEPEL Electronic Tube GENERATORS—1 KW; 2½ KW, 5 KW; 10 KW; 20 KW; 30 KW; 50 KW; 75 KW; 100 KW.

LEPEL Spark Gap Converters 2 KW; 4 KW; 7½ KW; 15 KW; 30 KW.

WRITE FOR THE NEW LEPEL CATALOG . . . 36 illustrated pages packed with valuable information.

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Circle 670 on Page 19

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WRITE FOR THIS COMPLETE CATALOG

NO TOOL CHARGE!

Wide selection of stock knobs, handles and plastic parts available without tooling cost to you! Many minor changes (color, design, inserts, threads, special materials, etc.) can be made to meet your requirements.

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Circle 671 on Page 19

fractional horsepower at its finest!

RAE motors

Rae M-12 or M-13 with G-12 reducer. M-12 and M-13 motors AC/DC Universal or Shunt. 1/5 H. P. Max. G-12 gear unit 536:1 Max. and 100 in. lbs. Max. M-13 has ball bearings.

choice of leading manufacturers

Don't gamble with the success of your product! By careful analysis and testing together with RAE engineers you can assure the right motor for your needs.

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- DC Shunt Wound
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- Motors for Rheostat Control
- Motors for Electronic Control
- Permanent Magnet Motors and Gearmotors

Send for the "RAE" service sheet. It will help you supply the data necessary for recommendations and prices.

Rae MOTOR CORP.
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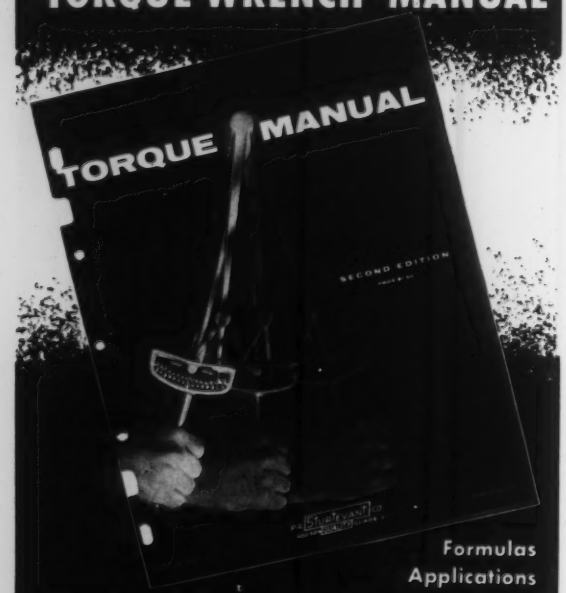
Circle 672 on Page 19

"TORQUE WRENCH" MANUAL



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Formulas
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Screw Torque Data
Adapter Problems
General Principles

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Manufacturers of over 85% of the torque wrenches used in industry

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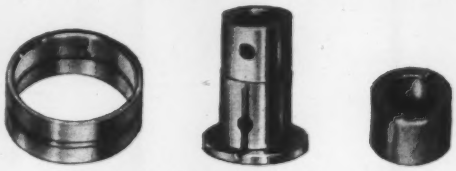
Moccasin BRONZE SLEEVE BEARINGS

Specialists in Special
CAST BRONZE BEARINGS



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Low fluid friction, high fatigue and compressive strength

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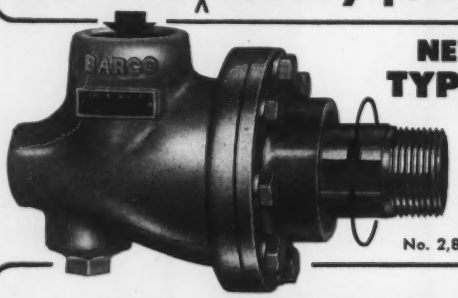
Circle 673 on Page 19

Need a Better rotary joint?



NEW TYPE C

Patent No. 2,836,439

-it's BARCO!

For countless applications, Barco's new Type C Rotary Joint will give you the best operating records you've ever had—*and for LESS COST!*

"CRACK-FREE" CHROME PLATED SLEEVE—A standard Barco feature. Minimizes corrosion, friction, wear. Stainless steel spring also standard.

RESISTS SEAL RING BREAKAGE—The spherical seal ring is under compression, not *tension*, loading. Self-adjusting for wear. Seal withstands shock loads and alternating hot and cold service.

WIDE SPACED BEARINGS—Two, instead of one . . . increased bearing area. No lubrication required. Lowest friction.

200 P. S. I. STEAM RATING—Heavy duty service at *no extra cost.* Eight sizes, ½" to 3". *Send for new Catalog 310 today.* **BARCO MANUFACTURING CO., 506M Hough Street, Barrington, Illinois.**

Circle 675 on Page 19

STAR STAINLESS SOCKET HEAD CAP SCREWS

Smooth and Knurled Types, Coarse, or Fine Thread. Sizes 0.80 and Up. Splined and Flat Head, Nylock and Socket Set Screws

RIGHT OFF THE SHELF®

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- WASHERS
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Circle 676 on Page 19

Wilbow

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This unique valve seat insert, molded by WILBOW integrally with steel wear rings, helps MUDWONDER* mud valves set new service records.

Mudline valve maintenance was a serious problem until MUDWONDER* valves began setting new standards of trouble free operation in oil fields all over the world. WILBOW engineers played an important part in achieving this remarkable performance . . . by helping to develop the molded buna-N-and-steel valve seat insert shown above.

WILBOW excels at producing special bonded rubber-to-metal parts from a full line of compounds including the *latest* synthetic, natural and silicone polymers. Let us help meet *your* needs, or perhaps you'll find our WILBOW catalog helpful. Send for your copy today.

*Registered trademark, Edward Valves, Inc., East Chicago, Indiana, Subsidiary of Rockwell Manufacturing Company.

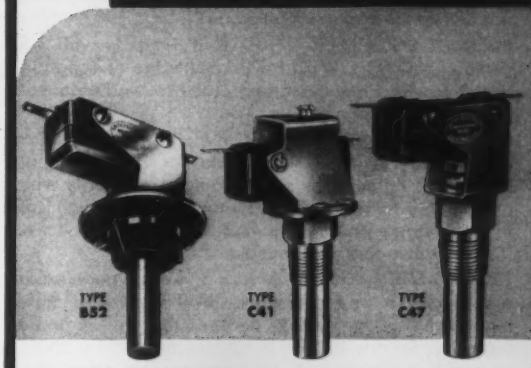
Wilbow

The WILLIAMS-BOWMAN RUBBER Co.
1951 South 54th Avenue • Cicero 50, Illinois • (Chicago Suburb)
Mfrs. of molded, punched, extruded and cut rubber goods. Specialists in producing rubber covered rolls, silicone rubber parts and bonding rubber to metal

Circle 677 on Page 19

SPACE OR WEIGHT LIMITATIONS?

B52 | C41 | C47



Specify Local Mounted UE SKELETON TYPE TEMPERATURE CONTROLS

UNITED ELECTRIC temperature controls are precision-built, compact and economical. Type B-52 was designed especially for controlling air temperatures . . . Type C41 and C47 for liquid or hot plate temperatures . . . These controls are direct-immersion units designed for easy installation.

Temperature Ranges	Type C41 & C47 100° or 200° between 0° and 425° F limits. Type B52 calibrated 40° F spans between 30° and 120° F.
Thermal Assemblies	various immersion lengths . . . liquid-filled seamless brass bellows operate by hydraulic action
Switch Ratings	15 amps or 20 amps at 115 or 230 volts A.C.; also D.C. switches available upon specification
Switch Actions	N.O., N.C., or Double Throw, no neutral position
Electrical Connection	attached directly to screw or solder terminals on switch
Size & Weight	approx. weight . . . 4½ oz., approx. size . . . 3⅞" x 2" x 1¼"
Variations	design variations available upon specification

UNITED ELECTRIC *manufactures a complete line of temperature, pressure and vacuum controls. For applications requiring custom-built units or modified standard units, call upon a UE application engineer for recommendations. Write for complete specification and pricing data on the Type B52, Type C41 or Type C47 local mounted temperature control, and for information regarding other United Electric temperature controls.*

U.E.®
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COMPANY
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Circle 678 on Page 19

OPPORTUNITIES . . . With A Growth Company

A progressive rapidly expanding manufacturer in the field of xerography (a method of physical photography based on solid state and electrostatic phenomena) has outstanding opportunities for:

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PROJECT ENGINEERS—M. E. or E. E. with 6-8 years experience. Will be responsible for all phases of manufacturing engineering including a familiarity with engineering design methods, tools and economical manufacturing processes. Also will direct the activities of other technical people.

PROCESS ENGINEER—M. E. with 5 years experience in machine tools and processes. Will investigate new manufacturing processes and equipment, prepare recommendations for the purchases of machine tools, and aid in developing tool engineering standards.

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Circle 679 on Page 19

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Life Saver size - only 7/16"x 3/4"

Renbrandt offers a complete line of ultra-compact, precision-made couplings featuring *zero backlash, low inertia and high flexibility.*

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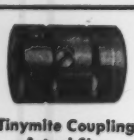

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Circle 680 on Page 19

ENGINEERS AVAILABLE OR WANTED

WANTED: MECHANISM'S DESIGNER & DRAFTSMAN. Excellent opportunity for Mechanical Engineer with creative ability to work in the design of automatic machinery. Work includes designing converting equipment for a medium-sized paperboard manufacturer and converter located in Michigan. Experience in paperboard products desirable, but not necessary. Salary commensurate with experience and ability. Excellent educational, cultural, and recreational facilities available in the immediate area. All replies held in strict confidence. Please send resume of educational background and work experience including present salary to Box 954. MACHINE DESIGN, Penton Bldg., Cleveland 13, Ohio.

WANTED: PROJECT ENGINEER. Mechanical or electrical, with firm theoretical background and machine design experience, is wanted by well-known progressive Central Pennsylvania material handling manufacturer. Diversified work from preliminary design studies to final prototype testing will offer opportunities for professional growth and advancement. Complete resume, references and salary requested in first letter preliminary to interview. Address Box 955, MACHINE DESIGN, Penton Bldg., Cleveland 13, Ohio.

WANTED: MECHANICAL ENGINEER. Leading manufacturer of laminated plastics, located in eastern Pennsylvania, has excellent opportunity for graduate M.E. with design experience in product and manufacturing methods. Knowledge of related tool design and tool making desirable. Must have initiative, leadership, and ability to keep abreast of modern developments. Working and living conditions are first rate. Give all details of education and experience in first letter. Address Box 956, MACHINE DESIGN, Penton Bldg., Cleveland 13, Ohio.

WANTED: DESIGN ENGINEER. One of the nation's leading manufacturers of school equipment, located in the mid-west is seeking an experienced machine or product designer. Applicants must be graduate M.E.'s with 5 years experience in design including some layout. A working knowledge of metals, wood or plastics is desirable. Supervisory experience or the potential for leadership is also desirable. Position consists of designing product starting from written specifications or existing product and developing product for special applications. This is an outstanding opportunity for personal growth with a rapidly expanding firm. Exceptional salary to start. Send complete resume, stating present salary to: Box 957, MACHINE DESIGN, Penton Bldg., Cleveland 13, Ohio.

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Published by
THE PENTON PUBLISHING COMPANY

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R. C. JAENKE .....President
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Subscription in United States, possessions, and Canada for home-addressed copies and copies not qualified under above rules: One year, $10. Single copies $1.00. Other countries: One year, $25. Published every other Thursday and copyrighted 1959 by The Penton Publishing Co., Penton Bldg., Cleveland 13, Ohio. Accepted as Controlled Circulation publication at Cleveland, Ohio.

BPA NBP

backtalk——

—Press Agent for Engineers

You may become famous—or at least attain that degree of fame that gets your name in the paper—if a current project of Engineers Joint Council is successful. EJC is attempting to educate the press to educate the public on the subject of engineers and engineering. A series of ads, one of which is reproduced here, is appearing in *Editor and Publisher*, the business magazine of the newspaper profession.

One of a series

The Big "W"

Who, what, when, where and why still belong somewhere in the news story. And who still leads the list.

Your theater columnists don't review plays without naming the actors. Your book reviewer names the author. Your whole staff is aware that names still make news.

Too often, engineering news events are reported as if they somehow, miraculously, got done, happened, evolved.

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Engineers Joint Council
29 West 39th St., N. Y. 18, N. Y.
For information, call Pennsylvania 6-9220

Besides encouraging the use of proper names, the EJC ads offer assistance to the press in interpreting the jargon of engineering and in providing facts about the profession and the part engineers play in new developments.

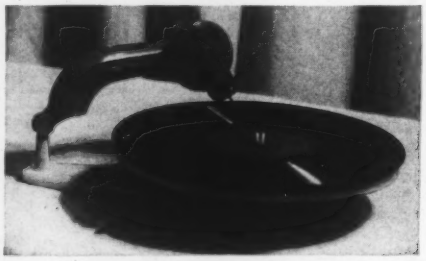
—Satisfying the Muses

One of the culture-seeking girl people in our office, reporting on her visit to an art museum, observed that long exposure to "this engineering business" had bent—if not warped—her aesthetic sense. "The girl I was with became quite enthusiastic over one big abstract painting, a labyrinth of brownish lines on a light background. All I could say was that, to me, it looked like the world's largest printed circuit."

Balancing this effect, the cover of this issue does a dandy job of blending engineering and artwork. George Farnsworth's covers always depict their subject articles effectively, but this particular one looks to us almost as much like a reflection of early South American art as it does a bunch of extrusions. Our art lover pronounced it "lovely," and the rest of us agree that it is truly one of George's handsomest efforts. If, in your haste to get at the innards of this issue you only glanced at the cover, do take another look.

—Truly Hi Fi

Like the little boy who excitedly described an old Victrola in the neighbor's attic ("You don't have to plug it in or nuthin' . . ."), several editors of MACHINE DESIGN showed great interest in literally trying their hands at operating the Finger Fono pictured here. Assistant Editor Ted Leach, who is associated with the American Bible Society, brought in one



of these rudimentary record players which the Society is distributing, along with 7 or 8-in. records with Scripture passages in appropriate languages, to illiterate people throughout the world.

In developing the Finger Fono, a hand-turned RCA phonograph was fitted with a new tone arm and a refined sound box. Diaphragm is in the arm. All major parts are plastic, and the whole works weighs just 4½ ounces.

—The Inner Man

The Finger Fono reminded us of the story which everyone has heard about the enterprising young man who is packaging human ashes and selling them to cannibals as "Instant People." One young man, however, also offers a cook book, *One Thousand Ways To Serve Your Fellow Man.*

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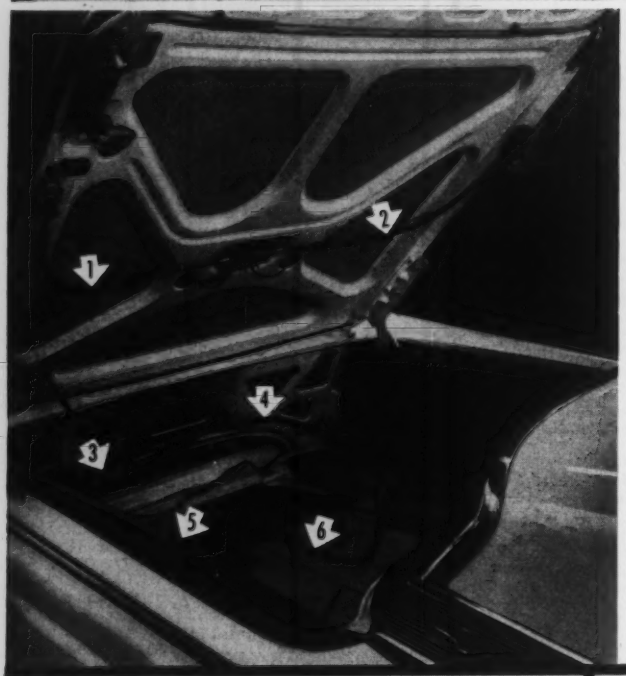
S. S. White DRIVE AND CONTROL IDEAS FOR ENGINEERS

Tips on better designing with flexible shafts

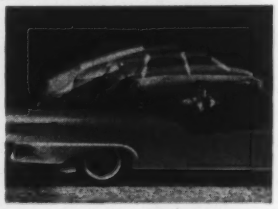
REMOTE CONTROL AND POWER DRIVE:

Retractable hard top simplified by flexible shafts.



In the Ford Fairlane 500 Skyliner, the roof retracts into the trunk, and the trunk lid closes and locks. All this is done automatically, within 40 seconds. Powering this ingenious mechanism are six 3/16" high speed, remote control flexible shafts, driven by three reversible electric motors.

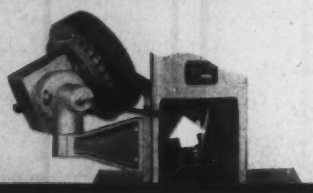
The use of flexible shafts enabled the designers to use only one motor to drive each pair of actuators, thus solving synchronization problems and at the same time cutting down on the number of motors needed.



Flexible shafts (1) and (2) rotate the trunk lid locking screws in and out of engagement. Flexible shafts (3) and (4) drive a pair of screw-jack actuators to raise or lower the trunk lid. Flexible shafts (5—not shown) and (6) drive a pair of actuators and their associated linkage to raise or retract the roof.

POWER DRIVE:

Powering a movable component . . . is easily accomplished with flexible shafts. Position of barrel type feeder on this new Detroit Power Screwdriver is highly adjustable, because it is driven by a flexible shaft. Power take-off is at the main drive motor.



COUPLING:

Solve alignment and vibration problems . . . with S. S. White coupling shafts — short pieces of flexible shafting without companion casings. Here is one being used between an adjustable pulley and a gear pump.

1057

S. S. White® IN FLEXIBLE SHAFTS

S. S. WHITE INDUSTRIAL DIVISION Dept. 4
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WRITE FOR COMPLETE DATA!

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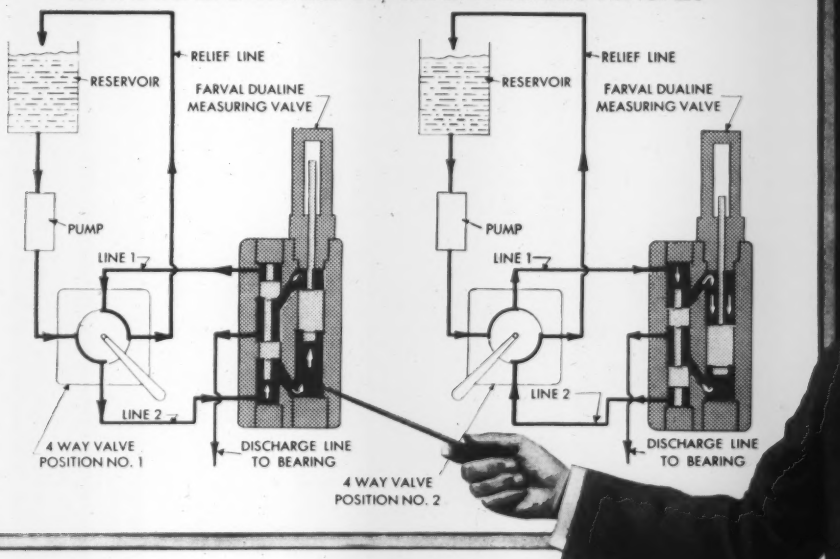
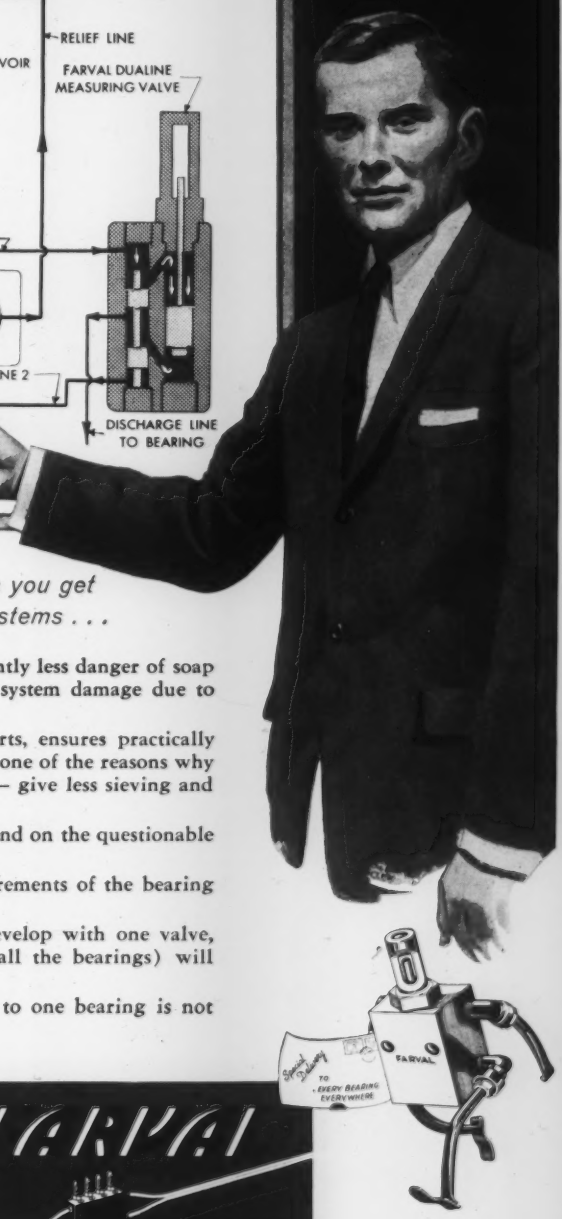
No. 246

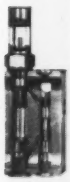
"For positive lubrication of large, medium and heavy-duty installations . . . it's a Farval Dualine System!"

FARVAL DUALINE SYSTEMS USE SIMPLE HYDRAULIC PRINCIPLES





With Farval Dualine centralized lubricating systems you get the following distinct advantages over other type systems . . .



(a) Much lower operating pressures with consequently less danger of soap separation on grease systems. Also, less danger of system damage due to high lubricant pressures.

(b) Large lubricant passages with no pinhole ports, ensures practically full pump pressure for every metering valve. This is one of the reasons why Farval Dualine systems operate on lower pressures — give less sieving and working of lubricants.

(c) Positive indication at each bearing — does not have to depend on the questionable action of a single indicator at the pump.

(d) Each metering valve individually adjustable for the requirements of the bearing it serves.

(e) Independent metering valve operation. Should trouble develop with one valve, the system will continue to operate. Only one bearing (not all the bearings) will require hand lubrication until trouble is corrected.

(f) True lubricant metering. Quantity of lubricant delivered to one bearing is not dependent on any other valve in the system.

(g) Much easier to spot and correct trouble.

Check with your Farval Representative and see how these versatile systems can improve production operations — reduce costs. Or write for free Bulletin 26-T containing complete engineering information on Farval Dualine systems. The Farval Corporation, 3287 East 80th Street, Cleveland 4, Ohio.

Affiliate of The Cleveland Worm & Gear Company
A subsidiary of Eaton Manufacturing Company

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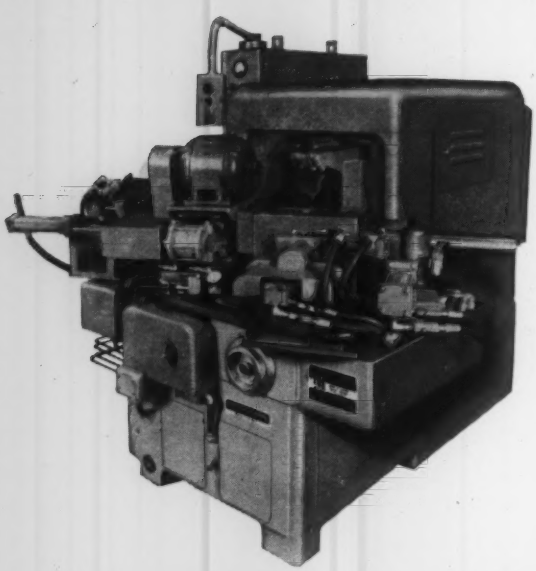
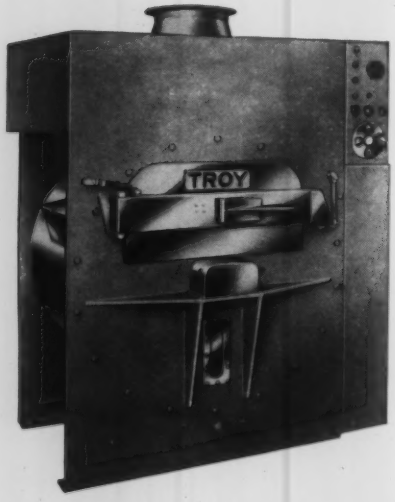


Jones and Lamson Machine Company's Automated Model E Form Grinder is designed to grind the helical form on a steering worm for a major automotive manufacturer. Cutler-Hammer Motor Control is supplied with these machines.

Miller Electric Manufacturing Company, Inc. installs Cutler-Hammer Three-Star Contactors on their Gold Star SR-400 Rectifier Type D-c Welders because, "Our use of Cutler-Hammer Contactors has completely eliminated contact welding and interphase or line-to-load flash-over."



The Troy Laundry Machine Division of American Machine and Metals, Inc. uses Cutler-Hammer Three-Star Motor Control on this Combination Washer-Extractor. Rated at 100 lbs. dry weight capacity, it processes industrial laundry with minimum effort, time, and costs.

Choice of the leaders

CUTLER-HAMMER CONTROL C-H

...the mark of better machines

The proper performance of any machine requires dependable, trouble-free service from the motor control which directs and protects it. This is why leading machinery builders use Cutler-Hammer Control. It installs easier . . . works better . . . and lasts longer.

For prompt attention to your control requirements, write Dept. W243, Cutler-Hammer Inc., Milwaukee 1, Wisconsin.

CUTLER-HAMMER

Cutler-Hammer Inc., Milwaukee, Wis. • *Division:* **Airborne Instruments Laboratory.** • *Subsidiary:* **Cutler-Hammer International, C. A.**
Associates: Canadian Cutler-Hammer, Ltd.; Cutler-Hammer Mexicana, S. A.; Intercontinental Electronics Corporation.

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